California Energy Commission

DRAFT STAFF REPORT

THE ELECTRIC PROGRAM INVESTMENT CHARGE

PROPOSED 2012-14 TRIENNIAL INVESTMENT PLAN

CALIFORNIA
ENERGY COMMISSION

Edmund G. Brown, Jr., Governor

SEPTEMBER 2012

CEC-500-2012-082-SD

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ABSTRACT

The California Energy Commission has prepared this triennial investment plan (2012 – 2014) for the new Electric Program Investment Charge (EPIC) Program in response to the California Public Utilities Commission's May 31, 2012, Phase 2 Decision 12-05-037. This CPUC decision established the EPIC Program to fund electric public interest investments in applied research and development, technology demonstration and deployment, and market facilitation for clean energy technologies.

The CPUC approved a total of $162 million annually for the program for the four administrators – the Energy Commission, Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE) and San Diego Gas & Electric Company (SDG&E). The Energy Commission is administering 80 percent of the approved EPIC research funds, or $127.8 million per year, beginning on January 1, 2013, while the three investor-owned utilities (IOUs) are administering 20 percent of the funds, or $33.3 million, with $0.8 million allocated to the CPUC for program oversight.

This first EPIC Investment Plan was developed through an open and transparent process that involved public workshops and consultation with key stakeholder groups. Input from these stakeholders is reflected in the recommended funding initiatives discussed in detail in the program plan in Chapters 3, 4 and 5.

The CPUC will conduct a formal proceeding, starting in November 2012, to consider this plan, with anticipated adoption in May 2013. The IOUs are developing their own investment plans to fund technology development and deployment initiatives. The Energy Commission is working to coordinate its investment plan with the plans of the IOUs.

Keywords: California Energy Commission, Electricity Program Investment Charge, applied research and development, technology demonstration and deployment, market facilitation, and clean energy technologies, and renewable energy, guiding principles, electricity value chain, energy innovation pipeline, energy efficiency, smart grid, clean generation

Please use the following citation for this report:

California Energy Commission, 2012. *The Electric Program Investment Charge: Proposed 2012-2014 Triennial Investment Plan*, Staff Report. Publication Number CEC-500-2012-082-SD.

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Executive Summary

Energy Commission staff developed this draft of the *Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan* with stakeholder input. Staff held scoping workshops for stakeholder input on August 2-3, 2012, in Sacramento and on August 9-10, 2012, in Los Angeles.

The California Public Utilities Commission (CPUC) established the purposes and governance for the Electric Program Investment Charge program (EPIC) in Decision 12-05-037 for Rulemaking 11-10-003 on May 24, 2012, available online at: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/167664.pdf. In this decision, the CPUC designated the Energy Commission as one of four administrators of the program and required administrators to submit coordinated investment plans to the CPUC for consideration no later than November 1, 2012. The other designated administrators are Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE), each of which are charged with administering a portion of EPIC program funding.

The portion of the EPIC program administered by the Energy Commission will provide funding for applied research and development, technology demonstration and deployment, and market facilitation for clean energy technologies and approaches for the benefit of ratepayers of PG&E, SDG&E and SCE. The CPUC plans to hold a proceeding to consider investment plans submitted by the four administrators. The current schedule anticipates a CPUC decision adopting or modifying the investment plans in May 2013.

The Energy Commission's development work on the EPIC investment plan is being conducted in accordance with recent legislation, Senate Bill 1018 (Chapter 39, Statutes of 2012), and overlaps significantly with the Energy Commission's broad authority under Public Resources Code Sections 25216 (c) and 25401. Senate Bill 1018 establishes the *Electric Program Investment Charge Fund* in the State Treasury to receive EPIC program funding to be administered by the Energy Commission and authorizes the Energy Commission to use this funding as authorized by the CPUC and appropriated by the Legislature (Pub. Resources Code § 25711).

Public Resources Code Section 25216, subdivision (c), provides that in addition to other duties specified in Division 15 of the Public Resource Code, the Energy Commission shall "carry out, or cause to be carried out, under contract or other arrangements, research and development into alternative sources of energy, improvements in energy generation, transmission, and siting, fuel substitution, and other topics related to energy supply, demand, public safety, ecology, and conservation which are of particular statewide importance." (Pub. Resources Code § 25216, subd. (c))

Public Resources Code Section 25401 directs the Energy Commission to "continuously carry out studies, research projects, data collection, and other activities required to assess the nature, extent, and distribution of energy resources to meet the needs of the state, including but not limited to, fossil fuels and solar, nuclear, and geothermal energy resources.." and also directs

that it "carry out studies, technical assessments, research projects, and data collection directed to reducing wasteful, inefficient, unnecessary, or uneconomic uses of energy." (Pub. Resources Code § 25401.)

Energy Commission staff developed the draft of the *Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan* with input and guidance from Energy Commission Chair Robert B. Weisenmiller, in his capacity as the lead commissioner on research, development, and demonstration matters, and with input and guidance from Commissioner Carla Peterman, in her capacity as lead commissioner on renewable energy matters.

CHAPTER 1: Introduction

The California Energy Commission has prepared this triennial investment plan for the new Electric Program Investment Charge (EPIC) Program in response to the California Public Utilities Commission's May 31, 2012, Phase 2 Decision 12-05-037.[1] This CPUC decision established the EPIC Program for funding electric public interest investments. This triennial investment plan presents the Energy Commission's strategy for administering $368.8 million to fund applied research and development, technology demonstration and deployment, and market facilitation from 2012 to 2014 under the Electric Program Investment Charge (EPIC). EPIC will provide public interest investments in clean energy technologies and approaches for the benefit of electricity ratepayers of California's three largest investor-owned utilities (IOUs): Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE). The Phase 1 decision[2] authorized funding collections in 2012 of $143.4 million, and the Phase 2 decision authorized funding collections starting in January 2013 of $162 million per year, with 80 percent of those funds to be administered by the Energy Commission and 20 percent to be administered by the three IOUs. The Phase 2 decision also establishes ratepayer benefits as the mandatory guiding principal to guide investment decisions. All funds will be administered under the oversight of the CPUC, which will conduct triennial public proceedings to review coordinated investment plans by all four administrators.

The Energy Commission's development work on the EPIC investment plan is being conducted in accordance with recent legislation, Senate Bill 1018 (Chapter 39, Statutes of 2012), and overlaps significantly with the Energy Commission's broad authority under Public Resources Code Sections 25216 (c) and 25401. Senate Bill 1018 establishes the *Electric Program Investment Charge Fund* in the State Treasury to receive EPIC Program funding to be administered by the Energy Commission and authorizes the Energy Commission to use this funding as authorized by the CPUC and appropriated by the Legislature. (Pub. Resources Code § 25711.)

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1 California Public Utilities Commission, *Phase 2 Decision Establishing Purposes and Governance for Electric Program Investment Charge and Establishing Funding Collections for 2013-2020*, Rulemaking 11-10-003, Date of Issuance, May 31, 2012: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/167664.pdf

2 California Public Utilities Commission, *Phase 1 Decision Establishing Interim Research, Development And Demonstration, And Renewables Programs Funding Levels*, Rulemaking 11-10-003, Date of Issuance, December 21, 2011.

fuel substitution, and other topics related to energy supply, demand, public safety, ecology, and conservation which are of particular statewide importance." (Pub. Resources Code § 25216, subd. (c))

Public Resources Code Section 25401 directs the Energy Commission to "… continuously carry out studies, research projects, data collection, and other activities required to assess the nature, extent, and distribution of energy resources to meet the needs of the state, including but not limited to, fossil fuels and solar, nuclear, and geothermal energy resources.." and also directs that it "…carry out studies, technical assessments, research projects, and data collection directed to reducing wasteful, inefficient, unnecessary, or uneconomic uses of energy …" (Pub. Resources Code § 25401.)

Energy Commission staff developed the *Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan, Staff Draft* with input and guidance from Energy Commission Chair Robert B. Weisenmiller, in his capacity as the lead commissioner on research, development, and demonstration matters, and with input and guidance from Commissioner Carla Peterman, in her capacity as lead commissioner on renewable energy matters.

The CPUC's Phase 2 decision indicated that the determination to appoint the Energy Commission as an administrator of EPIC funds was based on the Energy Commission's status as the state agency created to develop and support state energy policy, preference of public agency administration over private entity administration, and numerous continuing statutory obligations to provide analysis and programs to support clean energy goals. The Energy Commission will administer the EPIC program with those criteria in mind.

The framework in this investment plan reflects five guideposts:

1) The investment plan enables cost-beneficial achievement of the state's clean energy goals. The funding allocations reflect the state's energy priorities as reflected in the "loading order." This investment plan portfolio includes an emphasis on achieving greenhouse gas (GHG) reduction; all cost-effective energy efficiency; 33 percent renewables; the transformation and electrification of the transportation sector; and a "smart grid"[3] that can promote this transformation.
2) The priorities put forward in this plan will accelerate "home-grown" technology innovation, creating the technologies, tools and products needed to reach these goals.
3) The project selection process is designed to:

3 The Energy Commission's vision of the Smart Grid is the thoughtful integration of intelligent technologies and innovative services that produce a more efficient, sustainable, economic, and secure electrical supply for California communities. Energy Commission website: http://www.energy.ca.gov/research/integration/smart_grid.html

   a. Select the most promising technology solutions that do not duplicate other ongoing public or private research activities.
   b. Assert downward pressure on administrative costs.
   c. Maximize in-state investments.
4) Ratepayer benefits are embodied in the entire plan from selection of funded initiatives to criteria for project selection.
5) The plan builds on lessons learned from the Energy Commission's programs and creates a new program that is updated to meet today's priorities and guidance from the CPUC decision.

Chapter 2 discusses the program directives of the EPIC Program, including the guiding principle of benefits to California's electric ratepayers and a number of complimentary benefits. Also outlined are the funding levels for each program research area, a discussion of the technology areas targeted for investment, the policy justifications for investments in energy research development and demonstration and the energy innovation pipeline.

Chapters 3, 4, and 5 describe how the planned investments in the 2012-2014 time frame relate to grid operations/market design; generation; transmission; distribution; and demand-side management.

Chapter 3 describes proposed strategic investment objectives in applied research and development. The objectives address funding gaps needed to help innovative energy technologies and approaches succeed. The chapter focuses on targeted investments in energy efficiency and demand response, clean generation, smart grid enabling clean energy and cross-cutting technologies. Each objective focuses on a number of key initiatives that will address the gaps in applied R&D funding for that technology area.

Chapter 4 maps out proposed strategic investment objectives in technology demonstration and deployment, with a focus on providing key bridge funding to scale up efficiency, renewables and clean transportation in a real world environment.

Chapter 5 addresses funding for the Market Facilitation program area, which aims to fill gaps in market processes for clean energy generation, such as regulatory and permitting barriers, workforce development, outreach, and project tracking.

Chapter 6 identifies a need for funding for the New Solar Homes Partnership (NSHP), which provides financial incentives for the installation of eligible solar energy systems on new homes, as part of the state's California Solar Initiative.

Chapter 7 discusses program administration including the following key elements of the investment plan identified by the CPUC.

- The amount of funding to be devoted to each program area
- Policy justification for the proposed funding allocation

- The type of funding mechanisms (such as grants and contracts) to be used for each investment area
- Project eligibility and selection criteria
- Per project funding limits, including match funding requirements
- Metrics for measuring benefits and success
- Treatment of intellectual property rights.

Chapter 8 addresses the methods for assessing the program's benefits and success based on the type of project, the energy use sector, type of technology, project funded and its stage in the energy innovation pipeline. These metrics of benefits and success are being incorporated into each phase of program development, ranging from solicitation planning to project agreement development, project management, and project closeout.

CHAPTER 2:
Program Directives

Investment Areas

The CPUC Phase 1 and 2 decisions stipulate funding investments and amounts in three defined areas:

- **Applied Research and Development** ($158.7 million; three-year funding to the Energy Commission) – defined as activities supporting precommercial technologies and approaches that are designed to solve specific problems in the electricity sector, including activities that address environmental and public health impacts of electricity-related activities, support building codes and appliance standards, as well as clean transportation with a linkage to electricity sector ratepayer benefits.
- **Technology Demonstration and Deployment** ($129.8 million; three-year funding to the Energy Commission and $86.6 million of three-year funding to the IOUs) – defined as the installation and operation of precommercial technologies or strategies at a scale sufficiently large and in conditions sufficiently reflective of anticipated actual operating environments to enable appraisal of the operational and performance characteristics and the financial risks. Twenty percent of the Energy Commission's 2012 – 2014 investment plan funds in this category will be set aside for bioenergy projects or activities.
- **Market Facilitation** ($43.3 million; three-year funding to the Energy Commission) – defined as a range of activities including program tracking, market research, education and outreach, regulatory assistance and streamlining, and workforce development to support clean energy technology and strategy deployment. The Phase 2 decision further clarifies that this category should not necessarily be limited to renewables but may also include any other clean energy technologies and/or approaches.

A fourth area, market support, was not allocated funding in the decision, but as discussed below, the New Solar Homes Partnership (NSHP) fits in this category.

- **Market Support** (No funding is allocated for this category) − defined as activities and programs that support commercially viable technologies that still need public support to achieve economies of scale and be competitive with other technologies. The CPUC decision stated that if a change in legislation allowed EPIC funds to be used for NSHP, the CPUC may consider adding $25 million per year to EPIC for NSHP incentives.

Total EPIC funding for the Energy Commission activities is summarized in Table 1.

Table 1: California Energy Commission EPIC Funding by Program Element From 2012-2014 (in millions)[4]

Funding Element	2012	2013	2014	Total
Applied Research (AR)	48.7	55.0	55.0	158.7
Technology Demonstration and Deployment (TD&D)	39.8	45.0	45.0	129.8
Market Facilitation (MF)	13.3	15.0	15.0	43.3
Program Administration (PA)	11.3	12.8	12.8	36.9
Sub Total	**113.1**	**127.8**	**127.8**	**368.7**
New Solar Homes Partnership (NSHP)	0.0	up to 25.0	up to 25.0	up to 50.0
Total	**113.1**	up to **152.8**	up to **152.8**	up to **418.7**

Guiding Principles

The mandatory guiding principle of EPIC is to develop a new program that invests in clean energy technologies and approaches that provide electricity ratepayer benefits of promoting greater reliability, lower costs, and increased safety. In addition, the following complementary guiding principles are adopted:

- Societal benefits
- Greenhouse gas emissions mitigation and adaptation in the electricity sector at the lowest possible cost
- The loading order
- Low-emission vehicles/transportation
- Economic development
- Efficient use of ratepayer monies

In addition, principles articulated in California Public Utilities Code Sections 740.1 and 8360, which govern utility expenditures in the areas of RD&D and smart grid, are to serve as guidance. Section 740.1 states that, in evaluating research, development, and demonstration projects, consideration will be given to[5]:

- Projects that provide reasonable probability of ratepayer benefits.
- Minimizing projects with a low probability of success.
- Projects consistent with the utility corporation's resource plan.
- Projects that are not duplicative of previous or current research by other electrical or gas corporations or research organizations.
- Projects that support one or more of the following objectives:

4 Refer to Footnote 1 for CPUC Phase 1 and 2 decisions.

5 Public Utilities Code § 740.1: http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=00001-01000&file=727-758

- Environmental improvement
- Public and employee safety
- Conservation by efficient resource use or by reducing or shifting system load.
- Development of new resources and processes, particularly renewables resources and processes, that further supply technologies.
- Improve operating efficiency and reliability or otherwise reduce operating costs.

Section 8360 states the requirements for the state's electrical transmission and distribution system to maintain safe, reliable, efficient, and secure electrical service to meet future growth and demand in achieving the following[6]:

- Increased use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid.
- Dynamic optimization of grid operations and resources, including appropriate consideration for asset management and use of related grid operations and resources, with cost-effective full cybersecurity.
- Deployment and integration of cost-effective distributed resources and generation, including renewable resources.
- Development and incorporation of cost-effective demand response, demand-side resources, and energy-efficient resources.
- Deployment of cost-effective smart technologies, including real-time, automated, interactive technologies that improve the physical operation of appliances and consumer devices for metering, communications concerning grid operations and status, and distribution automation.
- Integration of cost-effective "smart" appliances and consumer devices.
- Deployment and integration of cost-effective advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.
- Provide consumers with timely information and control options.
- Develop standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
- Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Matrices have been included in Chapters 3, 4, and 5 to identify the specific benefits (or guiding principles) targeted for each proposed initiative investment.

6 Public Utilities Code § 8360: http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=08001-09000&file=8360-8369.

Electric System Value Chain

Phase 2 of the decision requires all investments be mapped to the different elements of the electricity "value chain," which was characterized as consisting of:

- Grid operations/market design.
- Generation.
- Transmission.
- Distribution.
- Demand-side management.

Similar to the guiding principles above, each initiative in Chapters 3, 4, and 5 includes a matrix and is mapped to the electric system value chain.

EPIC Investment Strategy

California energy policy frames a vision for our electricity future that includes an aggressive transition from fossil generation to renewable sources, highly efficient homes and businesses, and electrification of portions of the transportation system. The role of the Energy Commission's EPIC program is to provide the tools, technologies and market assistance that accelerate achievement of this vision in IOU service territories, at a reasonable cost, without sacrificing safety and reliability. To accomplish this, the Energy Commission staff proposes strategic improvements to help bridge gaps along the "electricity value chain."

Homes and business need high quality, cost-effective efficiency products and services. Renewable generation and electric transportation must be seamlessly integrated into the electricity power grid at all levels of interconnection, including small-scale home applications, to large central-station power plants. The Energy Commission's Integrated Energy Policy Report and ongoing analysis at the California ISO, the CPUC, the US DOE, and the US EPA have identified key challenges to achieving this clean energy vision for California's investor owned service territories. Each of the initiatives described in chapters 3-5 address an important barrier and investment gap.

Vision that Drives EPIC Investments

California's future electricity system will consist of near net zero energy buildings, highly efficient businesses, low carbon generation, sustainable waste to energy systems, more localized generation, and electrification of transportation, supported by a highly flexible and robust distribution and transmission infrastructure.

EPIC Program Mission

The Energy Commission through EPIC will fill critical funding gaps within the energy innovation pipeline to advance technologies, tools, and strategies that provide California's IOU ratepayers with clean, affordable, and reliable electricity and help enable the 21st century power grid.

California's Energy Policy

Imbedded in the directives outlined above, including the guiding principles, is the expectation that the Energy Commission achieve the state's clean energy policy goals, while promoting greater reliability, lower costs, and increased safety. California continues to lead in promoting the advancement of clean energy goals, such as those directed at reducing greenhouse gas emissions and ensuring an aggressive portfolio of renewable energy sources. The Energy Commission's EPIC Program used these goals to guide the development of strategic objectives outlined in this plan.

Governor Brown's Clean Energy Jobs Plan

By 2020, California should produce 20,000 new megawatts (MW) of renewable electricity, accelerate the development of energy storage capacity, and strengthen energy efficiency measures. This includes installing 8,000 MW of renewable central station capacity and 12,000 MW of renewable distributed generation. The plan also calls for the goal of adding 6,500 MW of combined heat and power systems over the next 20 years.[7]

Integrated Energy Policy Report

Senate Bill 1389 (Bowen and Sher, Chapter 568, Statutes of 2002) requires the Energy Commission to: "[C]onduct assessments and forecasts of all aspects of energy industry supply, production, transportation, delivery and distribution, demand, and prices. The Energy Commission shall use these assessments and forecasts to develop energy policies that conserve resources, protect the environment, ensure energy reliability, enhance the state's economy, and protect public health and safety." (Pub. Res. Code § 25301(a)).

The *2011 Integrated Energy Policy Report* addressed, among other things, the development of energy efficiency, renewable electricity, distributed generation, and combined heat and power in California and recommended policies to foster the development of these areas in California.

Energy efficiency continues to be California's top priority for meeting new electricity needs and a key strategy for increasing jobs and reducing greenhouse gas emissions from the electricity sector. The central policies that aim to increase energy efficiency in the state include achieving all cost-effective energy efficiency, reducing energy use in existing buildings, and making all new residential construction in California zero net energy by 2020, and all new commercial construction zero net energy by 2030.[8]

As part of the *2011 Integrated Energy Policy Report* proceeding, the Energy Commission issued the *Renewable Power in California: Status and Issues* report, which discussed challenges to

7 Governor Brown's Clean Energy Jobs Plan, http://gov.ca.gov/docs/Clean_Energy_Plan.pdf http://gov.ca.gov/docs/Clean_Energy_Plan.pdf

8 California Energy Commission, *2011 Integrated Energy Policy Report*, http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf

developing renewables and achieving the goals in Governor Brown's Clean Energy Jobs Plan. The report identified five high-level strategies: prioritize geographic areas for development; evaluate costs and benefits of renewable projects; minimize interconnection costs and time; promote incentives for projects that create in-state benefits; and promote and coordinate existing financing and incentive programs for critical stages in the renewable development continuum. (*2011 IEPR*, p. 10) These strategies are the foundation for a more detailed Renewable Action Plan being developed as part of the *2012 Integrated Energy Policy Report Update.* The update will also include a summary of a recent assessment of combined heat and power technical and market potential.

Assembly Bill 32 and Executive Order S-3-05

The California Global Warming Solutions Act of 2006 (Assembly Bill 32 [Núñez, Chapter 488, Statutes of 2006])) requires the state to reduce GHG emissions to at or below 1990 levels by 2020. Executive Order S-3-05 established a goal to reduce GHG emissions to 80 percent below 1990 levels by 2050.

The Loading Order

Since 2003, California's energy policy has defined a loading order of resource additions to meet the state's growing electricity needs: first, energy efficiency and demand response; second, renewable energy and distributed generation; and third, clean fossil-fueled sources and infrastructure improvements. This strategy has had the benefit of reducing carbon dioxide (CO2) emissions and diversifying California's sources of energy.

Energy Efficiency

The CPUC *Energy Efficiency Strategic Plan* and the Energy Commission's *Integrated Energy Policy Report* sets zero-net-energy goals for new homes by 2020 and new commercial buildings by 2030.[9] The California Air Resources Board *Scoping Plan* sets a target of 32,000 gigawatt-hours of reduction from energy efficiency improvements by 2020.[10]

Renewables Portfolio Standard

California's aggressive Renewables Portfolio Standard requires all electricity retailers, including investor-owned utilities, to serve 33 percent of their retail sales with renewable energy procurement. The RPS is mandated under Public Resources Code 399.11.[11]

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9 California Public Utilities Commission, *California Energy Efficiency Strategic Plan, January 2011* http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/

10 California Air Resources Board, *Climate Change Scoping Plan,* http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

11 The RPS was enacted by Senate Bill 1078 (Sher, Chapter 516, Statutes of 2002) and subsequently modified by Senate Bill 107 (Simitian, Chapter 464, Statutes of 2006). In 2011, the RPS goal was increased to 33 percent by 2020 under Senate Bill x1-2 (Simitian, Chapter 1, Statutes of 2011).

Transmission and Distribution

Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009) mandates implementing and planning a smart grid, defined as an electric grid using computers and communications to gather, distribute, and act on information about the behavior of suppliers and consumers to improve efficiency, reliability, economics, and sustainability of electricity services.

To successfully implement the Renewables Portfolio Standard, it will be necessary to upgrade existing transmission facilities and build new ones to connect remote, large-scale generation to load centers. Proactively assessing environmental and land use challenges will greatly aid permitting to upgrade existing lines and build new ones to help meet the policy goals.

Transportation

Senate Bill 626 (Kehoe, Chapter 355, Statutes of 2009) codified Public Utilities Code Section 740.2, which directs the CPUC to adopt rules to evaluate policies and develop infrastructure sufficient to overcome barriers to the widespread deployment and use of plug-in hybrid and electric vehicles. Governor Brown's Executive Order B-16-2012 establishes expectations for agencies to expedite the rapid commercialization of zero-emission vehicles.

Energy Research Innovation Pipeline

Ensuring a reliable, safe, clean, and diverse electricity system remains one of the most important elements toward securing economic, environmental, and state energy security. The need to expand and diversify California's energy sources from traditional fossil fuel sources is now well understood and embedded in state energy policy. However, major barriers, including higher costs of new technologies, remain. Private sector investments in early-stage, untested technologies often present financing risks for profit-minded business models. The maturation process for new technologies from early- to market-stage adoption requires several steps known as the research innovation pipeline (Figure 1). The earliest phase of the innovation pipeline is basic or fundamental research; this is characterized as expansion of knowledge, without a predefined commercial application or invention in mind. Basic research lays the foundation for applied science, and there is no obvious commercial value to the discoveries that result from basic research.[12] The EPIC Program excludes basic research. This category is typically supported by national labs and research universities. The next phases of the innovation pipeline consist of early feasibility, such as lab or field research, to bench and pilot scale testing, to full-scale demonstration and deployment. The latter two steps also require monitoring and validation studies to provide proven assurances to be fully embraced by private markets.

Promising innovations often languish unless supported by public investments. Within the energy innovation pipeline, two critical stages of financing gaps have been recognized – the

12 http://www.lbl.gov/Education/ELSI/research-main.html.

bridge between moving beyond the applied research stage (for example, from lab to pilot-scale) and the bridge between moving from demonstration to commercialization. These two economic barriers are described by Jenkins and Mansur (2011) as the "Technology Valley of Death" and the "Commercialization Valley of Death" and considered the greatest barriers barring innovative energy prototypes and innovative entrepreneurs from entering the market place.[13]

In his 2006 article in *Innovations*, John P. Holdren of Harvard University outlined the acute need for investment and deployment on new technologies to limit dependence on oil exports without incurring excessive economic and environmental costs[14]:

> "In this context, the needed process of innovation in energy technology must be understood as not consisting only of research and development (R&D), but also of at least equal emphasis and resources devoted to demonstration at commercial scale and in diverse contexts of the technological improvements that R&D have made possible and to mechanisms to promote accelerated deployment of those demonstrated options that offer the greatest leverage for reducing important externalities and enhancing important public goods. The energy-technology-innovation "pipeline" is full of potentially valuable—even potentially crucial—technologies at every stage of development, and it is no less important to push along toward full commercialization those that are already close to that threshold than to be doing the applied research and early development needed to move forward the more "far out" possibilities."

Holdren also acknowledged that private sector investments in research development and deployment are inadequate due to corporate environments that rely on short-term and high rates of return, to which research and development are not likely to provide.

Within the energy innovation pipeline there are critical funding gaps not adequately addressed by the private sector due to market barriers. Private venture capital firms, while accustomed to making risky speculative bets on new technologies, avoid investing in early-stage technologies, opting to invest when a technology is only a few years from production.[15] Private funding is also rarely sufficient to fund energy technologies. Unlike software and other large tech industries, demonstrating and assessing precommercial energy technologies often require prohibitively large amounts of money over many years.

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13 Jenkins, J., & Mansur, S. (2011). Bridging the Clean Energy Valleys of Death: Helping American Entrepreneurs Meet the Nation's Energy Innovation Imperative. Breakthrough Institute. Retrieved from http://thebreakthrough.org/blog/Valleys_of_Death.pdf

14 http://www.policyinnovations.org/ideas/policy_library/data/energy_innovation

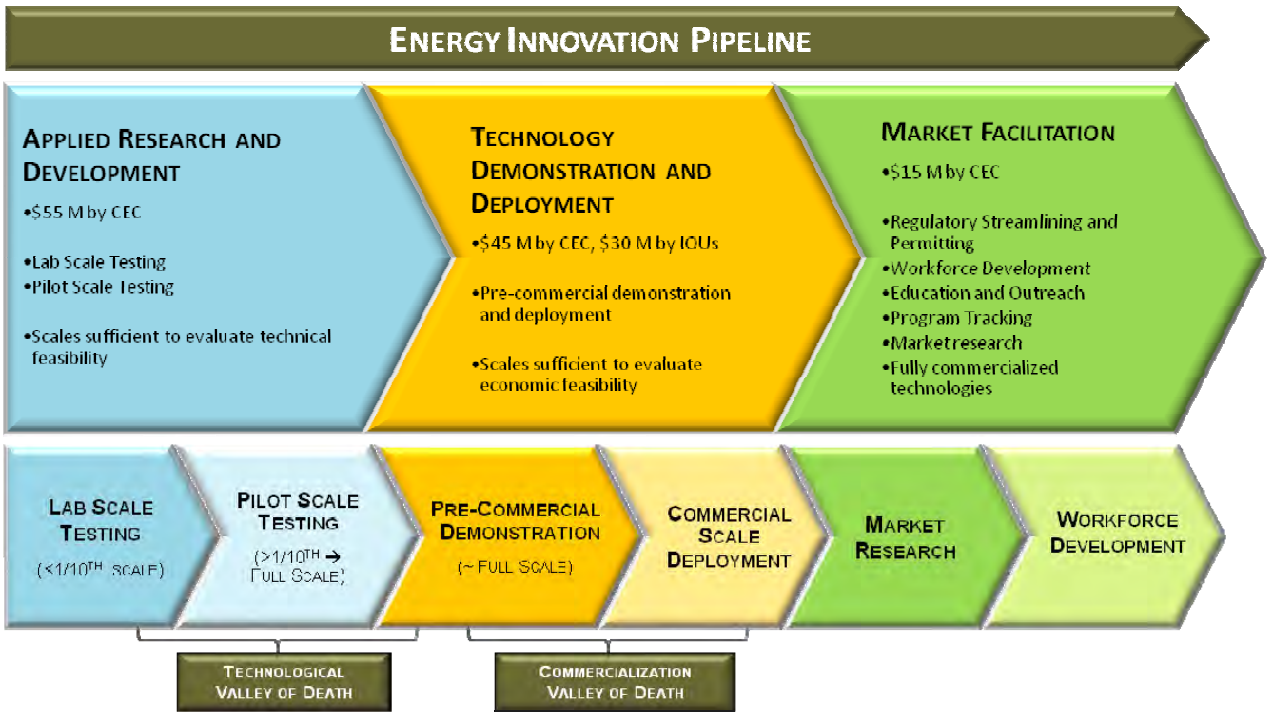
15 Weiss, C., & Bonvillian, W. (2009). *Structuring an Energy Technology Revolution.* Cambridge Mass.: MIT Press. Pg. 20.

To illustrate the type of research the Energy Commission expects to fund in EPIC, here are just a few examples of projects that returned significant ratepayer benefits that likely would not have received initial private sector funding:

- Synchrophasor research was seed funded over a decade by the U.S. Department of Energy (U.S. DOE) and the Energy Commission and matched by several utilities. A synchrophasor is a piece of hardware that provides real-time information about the performance of electrical transmission systems. Synchrophasors, and associated analysis tools, provide a more precise indication of transmission stability and an early warning of possible problems. Widely deploying synchrophasors in a smart grid will deliver power more reliably and efficiently and match load with the intermittent resources supplied by renewable generation. It is unlikely that the private sector would have invested in the broad development of synchrophasor applications even though the advancements have resulted in multimillion-dollar benefits in improved grid reliability as well as enabling increased renewable energy integration. This technology is most effective when deployed widely over the Western Interconnection, making it cost-prohibitive for one company to invest and profit from its development.
- Since its inception, the Energy Commission has conducted research to develop some of the most aggressive statewide energy efficiency standards in the nation. More recently, the results of research incorporated into California's Appliance Efficiency and Building Standards will result in annual cost savings of more than $1 billion for California electric and natural gas ratepayers upon full implementation. The annual cost savings are based on six research measures adopted into the codes: external power supply, residential furnace fan efficiency, television energy use, roofs that reflect heat (known as cool roofs) for homes, residential attic/duct model and battery chargers. It is unlikely that the private sector would have invested in such research.
- A significant challenge in developing renewable energy projects is often the lack of data necessary to complete environmental permitting requirements. The Energy Commission's research aided environmental review and permitting of renewable energy facilities in California deserts and contributes to the Desert Renewable Energy Conservation Plan (DRECP). The goal of the desert research program is to remove barriers and delays in the siting of renewable energy generation and transmission lines in the desert by addressing critical data gaps, which can hinder and lead to costly delays in environmental permitting. Though this research is just beginning, DRECP agencies and stakeholders are using these results to advise current environmental planning, permitting, analysis and designing renewable energy facilities that result in fewer environmental impacts. It is unlikely that the private sector would have financially invested in such research. However, it will benefit the state and ratepayers by advancing the state's RPS goal while ensuring that desert renewable energy projects provide clean energy and jobs while protecting the state's desert ecosystems.

The Energy Commission will focus EPIC investments on addressing barriers where private investment is either unlikely to be invested at all or will be inadequate to resolve barriers promptly. Investments will also be targeted to projects where publicly available data can reduce the cost of clean energy technologies to the ratepayers.

Figure 1: Energy Innovation Research Pipeline



Source: California Energy Commission

The CPUC's approach to investments in clean energy research recognizes these market-driven scientific and financial barriers by allocating funding to three separate, yet interconnected stages of development, as displayed in Figure 1. The Applied Research and Development program area will support precommercial technologies, providing funding needed to help bridge the Technology Valley of Death. Technology Demonstration and Deployment program area funding is devoted to install and test precommercial technologies or strategies at scales sufficient to appraise operational performance and financial risk. Finally, Market Facilitation funding is designed to support late-stage market barriers including monitoring, workforce development, public outreach and training, and regulatory assistance.

The Technology Demonstration and Deployment and Market Facilitation program areas will be crucial to bridge the Commercialization Valley of Death. Through the EPIC Program, the

Energy Commission will fill critical funding gaps to ensure an interconnected innovation pipeline for promising and innovative technologies that have the greatest potential to return benefits to the state's investor-owned utility ratepayers.

The Energy Commission investment plan outlines a series of *strategic objectives* and *research initiatives* that incorporate the decision's defined program areas, guiding principles, electricity value chain, policy, and other ratepayer benefits as described in the Decision. The strategic objectives and initiatives are based on current knowledge of state-of-the-art technologies and information, existing RD&D efforts, known barriers and knowledge gaps, as well as key factors driving clean energy development.

It is also crucial that EPIC be non-duplicative and focus on California's uniqueness. The research needs in California are often different from those pursued by the federal government. The federal government typically spends far more research dollars on developing new technologies and materials to lower the component costs of the new or emerging technologies. Given this focus by the federal government, California can best use state funds addressing technology integration and demonstrations closer to the end application. For example, over the last decade, the Department of Energy has spent billions on reducing the material and manufacturing costs of renewable technologies and California research efforts focused on renewable integration, reducing barriers to expanding renewables on the grid and demonstrating grid scale and customer renewable technologies. In contrast, demand response (DR) is critical to the management of the high peak load on the California grid and California has invested heavily in implementing new DR technologies, policies and the automation of DR. Conversely, the federal government has focused the majority of their efforts on national policy, rates, and tariffs and not technology development or demonstration. In critical areas such energy storage, microgrids, or distributed renewables, California often is a leader in fielding and demonstrating these technologies and can work actively with the federal government to jointly fund future efforts that are valuable to both missions. In some of these cases, California can be the test bed for the entire country. In other cases, California has unique attributes such as the hot dry climate where building and residential energy efficiency technologies that work well in California are not effective in the humid, moist areas of the North, East, and South. Also with California's location on the Pacific's "ring of fire" and because of tectonic plate convergences, California contains the largest amount of geothermal generating capacity in the United States and leads the industry in converting these resources into useful baseload renewable generation.

Due to the increased penetrations of intermittent renewables and the demand for more to come online given the aggressive 33 percent RPS, California will need to be at the forefront to address renewable integration issues. Further, California has some of the most polluted air basins in the country. Coupling that with some of the most progressive and forward thinking air quality district management organizations in the nation, California is also electrifying its transportation fleet to help meet the strict requirements by the air quality district management organization. System integration issues due to high penetration of electrical vehicles will also be an issue that

California will have to explore and lead the rest of the nation. Lastly, policy goals in California push for a more distributed electricity supply chain which will cause strains on the aging transmission and distribution grids. Integration of a distributed electricity supply will present unique challenges to California that research and develop dollars should target. In many cases, other states are delaying their efforts to see how the implementation efforts progress in California and they are looking for new and innovative technology solutions to help them meet their future energy needs. Under EPIC, the Energy Commission will continue this approach of ensuring the California funds and federal funds are leveraged to the maximum extent possible while still ensuring that the efforts being funded are not duplicative of work being done by other entities, federal or otherwise.

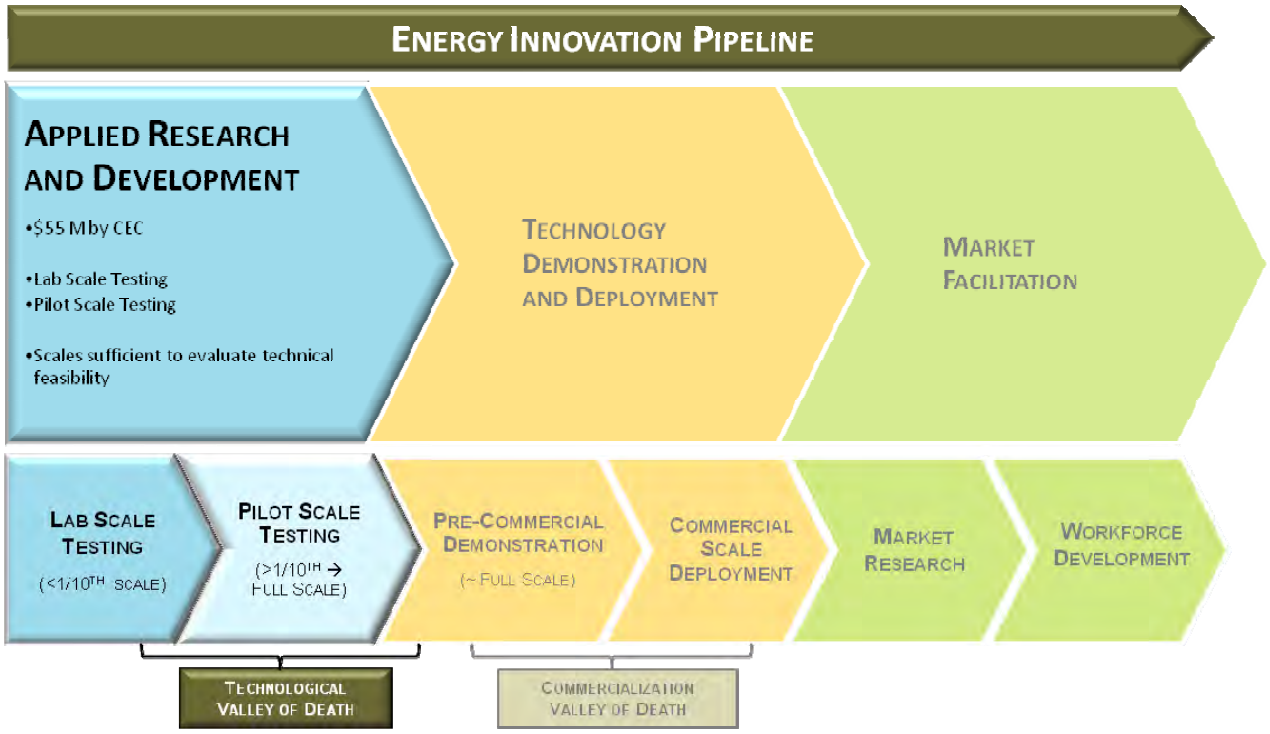
To reduce program implementation costs, the Energy Commission will build on and update existing research roadmaps and undertake new research roadmaps to further refine initiatives and funding priorities. Research roadmaps are expert- and stakeholder-driven documents that provide strategic guidance on prioritizing research initiatives by summarizing current research, data gaps, connection to state policy, potential impact by cost, urgency and timeliness of outcomes, and potential partnerships with other funding entities. Recognizing that funding decisions can be dynamic due to market, economic and political changes, these roadmaps are also dynamic, requiring periodic refinements or updates.

The following are example roadmaps and hyperlinks:

- PIER Industrial, Agricultural, and Water Energy Efficiency Program RD&D Targets: Consolidated Roadmap (http://www.energy.ca.gov/2011publications/CEC-500-2011-035/CEC-500-2011-035.pdf)
- Public Research on Advanced Generation Roadmap (http://www.energy.ca.gov/2012publications/CEC-500-2012-079/CEC-500-2012-079.pdf)
- California Utility Vision and Roadmap for the Smart Grid of 2020 (http://www.energy.ca.gov/2011publications/CEC-500-2011-034/CEC-500-2011-034.pdf)

The following chapters describe how the Energy Commission plans to help bring new energy technologies to market through this first triennial investment plan's proposed funding initiatives. To make this investment plan easier to navigate, the strategic objectives in Chapters 3, 4, and 5 are color coded, matching the program area addressed to the program area's color from Figure 1. Figure 1 is reproduced at the beginning of each chapter as a visual reference.

CHAPTER 3:
Applied Research and Development



Through the Applied Research and Development program area, the Energy Commission will address funding gaps needed to help innovative energy technologies and approaches overcome the "Technological Valley of Death." For this three-year investment plan, the Energy Commission will provide $158.7 million for applied research and development funding for development of new technologies, methods, and approaches from early bench-scale up to pilot-scale prototype demonstration, including activities that address environmental and public health impacts of electricity-related activities, support building and appliance standards and clean transportation. Each strategic objective below outlines a set of initiatives focused on a particular area of proposed research. The strategic objectives are:

- **Energy Efficiency and Demand Response**
    - S1 Strategic Objective: Develop next-generation end-use energy efficiency technologies and strategies for the building, water, and wastewater sectors

  - S2 Strategic Objective: Develop new technologies and applications that enable cost-beneficial customer-side-of-the-meter energy choices.

- **Clean Generation**
  - S3 Strategic Objective: Develop innovative technologies, tools and strategies to improve the affordability of distributed generation.
  - S4 Strategic Objective: Investigate emerging utility-scale clean energy generation technologies, systems, and deployment strategies in California.
  - S5 Strategic Objective: Reduce the environmental and public health impacts of electricity generation and make the electricity system less vulnerable to climate impacts.
- **Smart Grid-Enabling Clean Energy**
  - S6 Strategic Objective: Develop smart grid technologies, tools, and strategies to integrate intermittent renewables and other emerging technologies.
  - S7 Strategic Objective: Develop operational tools, models, and simulations for improved planning of grid resources.
  - S8 Strategic Objective: Integrate grid-level energy storage technologies and determine best use applications to provide locational benefits.
  - S9 Strategic Objective: Advance plug-in electric vehicle infrastructure and use EVs to improve the operation and performance of California's power grid.
- **Cross-Cutting**
  - S10 Strategic Objective: Leverage California's regional innovation clusters to accelerate the deployment of early-stage clean energy technologies and companies.

The following section provides each strategic objective under applied research and development, including associated planned initiatives**.**

Energy Efficiency

S1 Strategic Objective: Develop next-generation end-use energy efficiency technologies and strategies for the building, water, and wastewater sectors

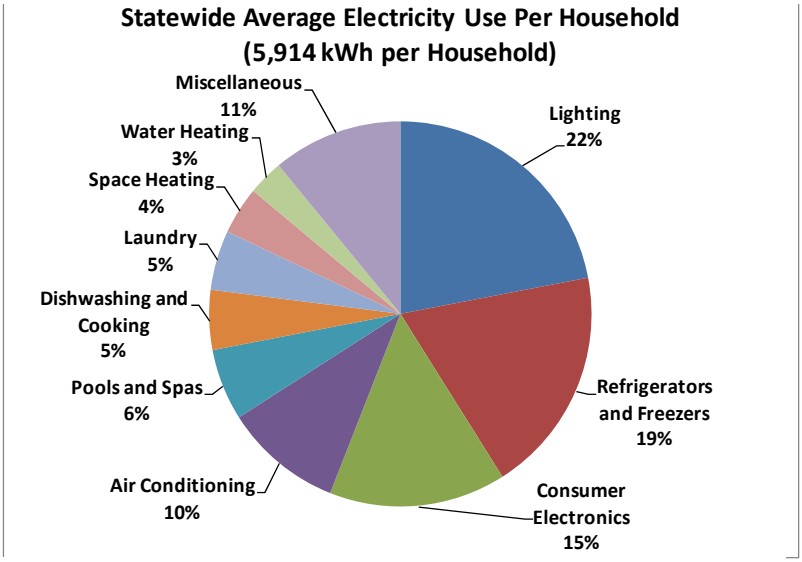
Table 2: Ratepayer Benefits Summary Table for Strategic Objective 1

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S1.1 Develop, Test and Demonstrate Next-Generation Lighting Systems and Components.	X	X		X	X		X	X	X
S1.2 Develop, Test, Demonstrate, and Integrate Advanced Equipment, Systems, and Components That improve the Energy Efficiency of Heating, Ventilation, Air-Conditioning, and Refrigeration Systems in Buildings.	X	X		X	X		X	X	X
S1.3 Develop, Test, and Demonstrate Advanced Building Envelope Systems, Materials, and Components.	X	X		X	X		X	X	X
S1.4 Investigate and Improve Understanding of Consumer Behavior to Increase and Sustain Energy Efficiency Improvements in Buildings	X	X		X	X		X	X	X
S1.5 Develop and Demonstrate Prototype Graywater Reuse Technologies and Approaches to Reduce the Need for Fresh Water in Buildings.		X		X				X	
S1.6 Develop Cost-Effective Retrofit Strategies to Achieve Greater Energy Efficiency in Existing Residential and Nonresidential Buildings.	X	X		X	X		X	X	X
S1.7 Reduce the Energy Use of Plug-Load Devices Through the Development of Products, Systems, and Controls, and Evaluation of Consumer Behavior That Affect Energy Use.	X	X	X	X	X		X	X	X
S1.8 Develop and Evaluate Ideal Strategies to Improve Indoor Air Quality in Energy-Efficient Buildings		X	X	X					
S1.9 Develop Cost-Effective Technologies and Approaches to Achieve California's Zero Net Energy Buildings	X	X		X	X		X	X	X

Source: California Energy Commission

Electricity use in residential and commercial buildings accounts for about 69 percent of electricity consumed in California. The Energy Commission and the California Public Utilities Commission have adopted a goal of achieving zero-net-energy building standards by 2020 for homes and 2030 for commercial buildings. Cost-effectively achieving these goals will require the development and adoption of advanced building energy efficiency technologies and strategies beyond what is currently commercially available.[16]

Figure 2: Statewide Average Residential Electricity Use



Source: California Energy Efficiency Strategic Plan, January 2011, page 10, http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/

Most of the electricity used in residential buildings is for lighting, air conditioning, refrigerators, and consumer electronics.[17] Research is needed to provide high-quality, more energy-efficient lighting at the lowest possible cost. More efficient air conditioning is needed to control electrical demand spikes on hot summer days, especially as homes in coastal areas add air conditioning and more homes are built in the in hot, dry climates of the Central Valley and the Inland Empire of Southern California. One of the fastest growing electrical consumption areas is consumer electronics, and research is needed to control energy use without hampering equipment performance. A comprehensive whole-building assessment needs to be done as it is clear that no one technology exists that will reduce energy consumption to the levels needed to reach the state's energy reduction goals for existing homes by 40 percent by 2020 and to achieve zero-net-energy-new homes by 2020.[18]

One of the most overlooked areas in the residential sector has been existing and multifamily buildings. Research initiatives are proposed for both technologies and strategies that will target these sectors to reduce energy use and cost.

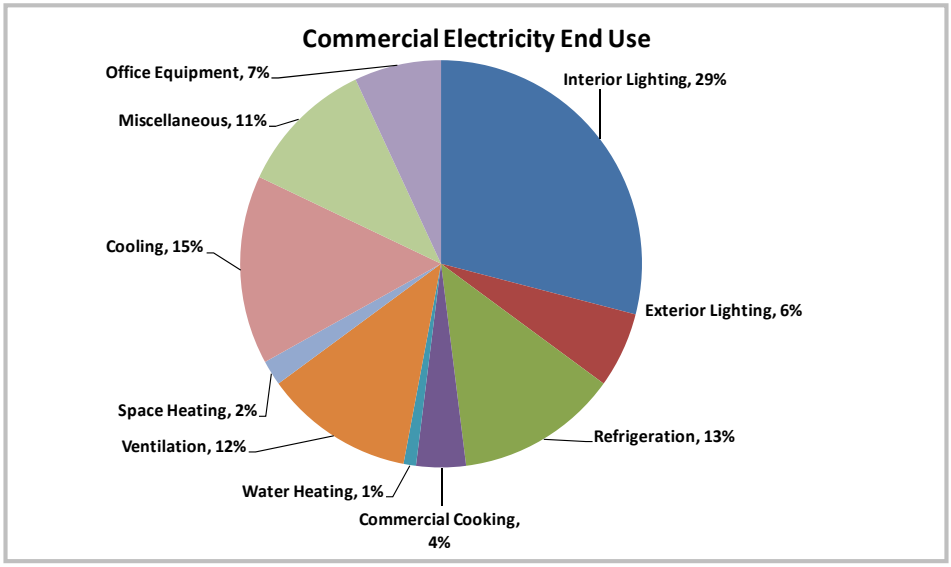
16 *California Energy Efficiency Strategic Plan.*

17 *California Residential Appliance Saturation Study*, 2010, www.energy.ca.gov/appliances/rass/.

18 Ibid, page 11.

For the commercial sector, most electricity is used for lighting, cooling and ventilation, refrigeration, and for miscellaneous and office electronics.[19] Significant strides have been achieved, but innovation is needed to increase the efficiency of lighting sources and their controls; cooling, ventilation, and refrigeration systems; and office electronics. This also includes integration of multiple technologies in whole buildings, due to the interactive effects that one technology can have on the other. For instance, reducing lighting load and improving the building envelope can affect air-conditioning and ventilation requirements. This comprehensive approach will be needed to achieve zero-net-energy use for new commercial buildings by 2030 and to achieve zero net energy or near zero net energy (with deep retrofits) for at least half of existing commercial buildings by 2030.[20] In addition to technologies, future research should also focus on existing small to medium commercial buildings. This area holds promise but has not seen many energy efficiency gains due to split incentives regarding building ownership and payment of utility bills.

Figure 3: Statewide Average Commercial Electricity Use



Source: California Commercial End Use Survey, March 2006, page 9, http://www.energy.ca.gov/2006publications/CEC-400-2006-005/CEC-400-2006-005.PDF

Achieving the transformational goals for the residential and commercial sector as stated in the *California Energy Efficiency Strategic Plan* will involve novel research including the development of advanced energy efficiency technologies, services, and products; evaluating energy user behaviors; and encouraging their use through utility incentive programs or building energy efficiency codes.

19 *Commercial End Use Survey,* 2006.

20 *California Energy Efficiency Strategic Plan*

Applied research on energy efficiency technologies and strategies, as described in this section, can provide the foundational justification for future utility rebate and incentive programs. The Energy Commission's EPIC Program plans to coordinate closely with the Emerging Technologies Coordinating Council (ETCC).[21] The ETCC would provide an opportunity for members to meet, collaborate, and exchange information on energy efficiency research and to provide a path for promising technologies to the marketplace. The ETCC focuses on identification, assessment, and rapid commercialization of energy-reducing technologies. The resulting products of the EPIC-funded applied research can help IOUs meet the energy efficiency goals set by the CPUC – namely that the IOU energy efficiency programs need to help California save 23 billion kilowatt hours of electricity and 45 million therms of natural gas. This is the annualized equivalent of taking nearly 2 million cars off the road and lighting 3.4 million homes.[22] Ratepayers benefit with better, lower cost-efficient projects with validated savings.

Other issues of interest in this strategic objective are water reuse, or "graywater" use in efficiently designed buildings and indoor air quality resulting from tighter building envelopes that trap potentially harmful substances inside. Indoor air quality is regulated by the California Environmental Quality Act, which mandates that potential impacts of such standards as building energy efficiency must consider human health and safety and must mitigate any significant adverse impacts.

S1.1 Proposed Funding Initiative: Develop, Test and Demonstrate Next-Generation Lighting Systems and Components.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X							**X**

Issue: Many new products promising efficient lighting, including light emitting diodes (LEDs), are beginning to enter the market, but more work is needed to realize the full potential of these light sources. LEDs may leapfrog over compact fluorescents and other lighting technologies due

21 Members of the ETCC include Pacific Gas and Electric, San Diego Gas & Electric, Southern California Gas, Southern California Edison, Sacramento Municipal Utility District, California Public Utilities Commission and the California Energy Commission.

22 Emerging Technology Coordinating Council, http://www.etcc-ca.com/about/11?task=view

to high efficiency and more diverse design options. However, cost, light spectrum quality, and fixture design are still in need of innovation. An additional opportunity is daylighting. Natural daylight is considered the highest quality light source, when properly designed and controlled. However, it is underused in most buildings. Control systems that could seamlessly integrate natural lighting with electric lighting need to be further developed. Despite the advent of automatic occupancy controls, many lights in existing buildings remain uncontrolled and remain on when they are not needed. Technology innovation can address these issues, enable energy savings, and improve performance.

Purpose: This initiative will conduct research that promotes the development and implementation of new technologies and market applications that foster lighting systems and components with improved energy efficiency and performance. The focus will be to:

- Improve and develop whole lighting systems and components.
- Develop design and simulation tools that will encourage cost-effective daylighting, as well as top retrofit strategies.
- Improve control systems to integrate electric lighting with natural lighting, coupled with optimal fixtures that lead to better overall light quality and consumer acceptance.
- Evaluate self-commissioning systems to compensate for installer inexperience, improve performance, and reduce installed costs.
- Conduct lab- and bench-scale tests to identify candidate technologies for incentive programs and minimum standards.

Background: Lighting consumes nearly 25 percent of California's electricity use, costing Californians about $10 billion annually. However, lighting offers significant opportunities for energy savings and peak demand reductions. Conventional lighting technologies present a primary challenge to the attainment of public policy goals to reduce the production of greenhouse gas (GHG) emissions (AB 32) and the growth in peak electricity consumption (SB-1250). Increased interest, awareness, and emphasis on energy efficiency combined with rapid technological advances in LEDs and lighting controls systems have transformed the lighting industry, creating opportunities for accelerated acceptance of new technologies that can expedite the reduction in energy consumption and GHG emissions.

Though significant gains have been made in lighting efficiency, continued innovation in energy-efficient lighting technologies and lighting systems is necessary to meet the *California Energy Efficiency Strategic Plan* goal of 60 to 80 percent reduction in electrical lighting energy consumption by 2020.[23] Lighting research focuses on advancing the Energy Commission and

23 http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf (see Chapter 13).

state energy policies by accelerating the development and commercialization of technologies through demonstration, outreach, education and training. This initiative will complement past and current work on lighting and controls.

S1.2 Proposed Funding Initiative: Develop, Test, Demonstrate, and Integrate Advanced Equipment, Systems, and Components that Improve the Energy Efficiency of Heating, Ventilation, Air-Conditioning, and Refrigeration Systems in Buildings.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Heating, ventilating, and air-conditioning (HVAC) systems are significant energy users in buildings and contribute to California's peak load problem. Finding ways to reduce the cooling load will be critical to reducing electrical demand, saving ratepayers money and improving system reliability. Efficiency gains also reduce energy consumption and are key to achieving the state's zero-net-energy building goals. Few HVAC and refrigeration systems perform at their maximum efficiency due to changes in design conditions, degradation, maintenance, and refrigerant issues. Over the life of the equipment, these factors can lead to lower efficiencies and greater energy consumption. Equipment innovations are leading to HVAC systems that can provide multiple services (heating, cooling, and water heating) or innovations in cooling systems that operate with multiple thermal sources. Component improvements are important, but not enough. Better components will increase system efficiencies and reduce peak load, but simulation and performance modeling are lacking that can provide proper compliance credit to encourage their use through utility incentive programs or the building energy efficiency codes. As a result, these innovations become underused.

Purpose: This initiative will focus on developing advanced energy-efficient HVAC and commercial refrigeration equipment and systems, including the development of simulation models, fault detection and diagnostic tools, improving performance of integrated HVAC and refrigeration systems, performance modeling rule sets to promote utility incentives and compliance credit for innovative systems, and development of test protocols to detect refrigerant issues (for example, leakage, contamination, and flow restrictions). The research aims to improve and develop equipment and whole systems that look at all components while also ensuring continued system performance and energy efficiency over time. This is

accomplished by developing fault detection and diagnostic tools and test protocols for use by contractors, raters, and others. Improved automated diagnostics for package and split-system air conditioners and refrigeration equipment will be developed, along with new approaches to both detecting and reducing refrigerant leakage, a source of greenhouse gasses.

Background: A large number of HVAC systems and components in California seldom operate at maximum efficiency. In industrial and commercial buildings, the HVAC and refrigeration systems often do not communicate with each other, which prevent these systems from being perfected and operating efficiently. Additionally these systems lose efficiency over time due to changes in design conditions and system modifications, and to slow refrigerant leakage or degradation of other parts. These factors lead to lower efficiencies and greater energy consumption over the life of the equipment. Consumers are generally unaware of this inefficiency and, therefore, do nothing to address it until the equipment fails.

Past research by the Western Cooling Efficiency Center, Center for the Built Environment and others focused on advanced evaporative air conditioners, radiant floor cooling, and underfloor air-distribution systems. For instance, research to evaluate the benefits of radiant cooling systems has resulted in the adoption of this technology by several Wal-Mart stores located in hot, dry climates. A ceiling-mounted radiant cooling system for homes is under development. Additional work is required to move these technologies to the next level and potentially integrate with other HVAC systems such as thermal energy storage. This initiative will further develop and pilot test these technologies, improve their performance and cost-effectiveness, and move them closer to wide-scale deployment and commercialization.

There has also been promising research on the development of automated tools for fault detection and diagnostics. These tools can help building operators detect and address operational problems promptly and reduce energy cost and waste automatically. However, additional research is needed to improve validation and standardization of these tools for a broader adoption by the buildings industry. Research is also needed to increase sufficient validated data collection for a variety of HVAC systems and system faults to increase confidence in diagnostic protocol evaluation. This tool will help HVAC contractors and facility managers make appropriate decisions to ensure energy efficient operations of equipment.

S1.3 Proposed Funding Initiative: Develop, Test, and Demonstrate Advanced Building Envelope Systems, Materials, and Components.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Building energy efficiency, durability, and habitability are largely determined by the building envelope, which consists of the structure's outer shell. Elements of the building envelope include doors, windows, skylights, roofs, walls, foundations and their constituent materials, as well as the overall envelope design in which the elements reside. New materials are now available, along with new manufacturing technologies and techniques for improving the efficiency performance of existing structures. These technologies and techniques show promise but often need further development and validation before they enter the market. Simulation tools often lack the capabilities to model specific benefits of these new systems and need enhancement to include characteristics of the new materials, components, and designs. For example, dynamic windows, electrically controllable to manage light transmittance, are now in an early stage of market deployment, but accurate simulation of the energy benefits of these windows will require further assessment of the window performance as well as further development of simulation tools.

Purpose: This initiative will conduct research to improve the performance of building envelope systems, materials, and components. The primary focus is to improve and develop cost-effective products, systems, and materials, including whole-building designs, manufacturing techniques, and simulation tools to ease their successful entry into the market and to advise future building energy efficiency standards. The initiative will:

- Identify needed improvements that can increase the energy efficiency of building envelope systems, materials and components. This will be accomplished by using research and product developments discovered during assessments and targeting other ongoing complementary research.
- Evaluate new materials and components for building envelopes and evaluation of durability and energy performance. For example, infrared reflective pigments have been incorporated into wall paints that may be able to reflect nearly half of the incident solar energy, potentially reducing cooling loads, but research is needed to validate their energy performance and durability.

- Assess the most effective ways to measure the performance of building envelopes and promote techniques that achieve high performance, including manufacturing processes.

Managers in the emerging technology programs at the California investor-owned utilities have expressed support for this type of research and have proposed that some research activities be conducted in harsher climates in Southern California.

Background: Research has been conducted to make buildings more efficient by promoting new envelope systems and other building components that are efficient, durable, and cost-effective. Examples of past research include:

- Fenestration: Lawrence Berkeley National Laboratory's (LBNL) Windows and Facades Test bed has looked at innovative ways to cut energy use in windows and window treatments, resulting in the development of improved modeling and simulation tools. New types of windows that dramatically reduce infiltration are used in passive houses in Europe, but the high cost of these windows is a market barrier in the United States. Assessments of the benefit of these windows, and development of manufacturing approaches, which can reduce their cost, are needed to ease their market entry. Windows often allow water to leak into the interiors of walls, potentially leading to mold growth. Window improvements that eliminate this source of leakage need development and independent validation to enhance building durability and ensure that these products perform as claimed.
- Roofing and building envelope: Past research has resulted in the development of innovative cool roof materials. New roofing materials include coatings that increase reflectivity and emissivity, keeping structures cooler during hot, sunny summer months, and efforts are underway to more effectively integrate solar photovoltaic cells into roofing materials. Other envelope improvements, such as insulation at the roof plane and sealed attics, are also being tested and need rigorous validation. Retrofit technologies, such as techniques for sealing existing building envelopes with adhesive mist, show great promise as well.
- Building manufacturing: Improvements in manufacturing processes, such as use of in-shop manufacturing and quality control for entire wall sections, can reduce waste and construction defects that typically plague site-built structures. The benefits of these techniques need assessment and possible credit in building standards. All of these new building techniques, materials, and components require updated simulation tools to provide accurate information to designers, engineers, and standards developers.

S1.4 Proposed Funding Initiative: Investigate and Improve Understanding of Consumer Behavior to Increase and Sustain Energy Efficiency Improvements in Buildings

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Energy used in buildings varies greatly depending on the behavior of its occupants. Understanding what motivates building occupants to make energy-efficient decisions can help tailor solutions that will result in real savings. Issues include:

- Determining the types of technologies and information needed by particular individuals and groups.
- How technology can be designed to provide useful and actionable energy information.
- How to accurately measure the effects of these strategies with the goal of significantly affecting awareness, concerns, and actions related to energy use.
- How best to quantify the many nonenergy benefits and their motivational impact.

Purpose: This initiative will conduct research to better understand the factors that motivate customers to make energy-efficient equipment purchases, and operate and maintain them in the most energy-efficient manner. The research will address the role of consumer choice and operational behavior in influencing the way equipment is designed and operated. It will also address how private and publicly supported energy efficiency programs can be improved to expand participation in target audiences. Examples of areas to be researched include:

- Determining the types of energy information that motivates different types of customers, by demographic, geography, and other characteristics, to make energy-efficient choices with respect to purchasing devices and equipment and operating energy using appliances in homes and workplaces.
- Answer key questions such as how, where, and when the information should be provided and/or displayed.
- Consider how the information should be framed, and to what degree and in what situations energy efficiency should be automated versus controlled by the end user(s).

- Research and describe the smart technologies available on the market that can program and automate energy using devices such that energy use can be reliably predicted for planning public or utility program initiatives.
- Test and determine the most effective ways to measure response(s) to energy information.
- Demonstrate technologies and promote market education and adoption.

Background: Through many workshops and public meetings sponsored by the Energy Commission and stakeholder input for the EPIC Program, the need and importance of operational behavior research associated with energy efficiency have been emphasized. The general consensus is that the operational aspect of energy use is extremely important and needs to be better understood. This understanding is critical to designing new technologies and programs that will achieve their full energy savings potential. Some utility companies are doing small-scale energy behavioral research.

In an ongoing Energy Commission/American Recovery and Reinvestment Act (ARRA)-funded study at Stanford University, preliminary projections indicate that intervention strategies that create energy awareness can result in energy reductions ranging from 5 percent to 30 percent. The research will provide valuable insights into what may be effective energy-conserving motivational techniques with respect to technology, incentives, and types of information. The research is scheduled to be completed in October 2013. The information from this study will provide useful information on where future research should be directed and how more effective utility-driven, energy conservation incentive programs should be designed.

S1.5 Proposed Funding Initiative: Develop and Demonstrate Prototype Graywater Reuse Technologies and Approaches to Reduce the Need for Fresh Water in Buildings.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Graywater in homes is the water drained from baths, showers, washing machines, and sinks that can be recycled for irrigation, evaporative cooling, and energy, power, and biofuels production. Graywater recycling is impeded by issues including regulatory restrictions, potential health risks, and the increased maintenance requirements of reusing lower quality water in certain systems. Research and development are needed to advance methods that

ensure reused water applications meet current regulations. The purpose is to show that specified uses of graywater will meet safety standards so that regulations can be adopted to allow greater use of graywater in place of fresh water for nondrinking purposes.

About 9 watt-hours per gallon of electric energy are required to pump fresh water from Northern California to Southern California via the State Water Project. Local wastewater agencies also consume electric energy for pumping wastewater. Addressing regulatory, health, and maintenance issues of graywater will allow for increased use of graywater systems, thus reducing the energy and costs associated with moving and treating fresh water and wastewater.

Purpose: This initiative will encourage research on graywater reuse technologies for building and industrial applications to reduce the use of freshwater and the subsequent production of wastewater entering sewer or septic systems. The goal is to establish when and why particular treatment/management options work and do not work with respect to temperature and water conditions. Potential target areas could include water reuse in irrigation, evaporative cooling, and energy, power, and biofuels production. In California, evaporative cooling is currently impeded by concerns about water consumption and maintenance issues. These two concerns are related as manufacturers consistently use additional water to reduce maintenance issues. Using evaporative processes for cooling buildings provides substantial energy savings over "dry" cooling. However, water use is a major concern for water agencies across California and is likely to become more so in the future. A fraction of the water consumed by small system evaporative cooling systems is used to dilute the concentration of dissolved solids, which is dumped from the system and wasted. Treatment systems are available that may be able to reduce the volume of this waste but they have not been demonstrated for these smaller systems. Organizations that have interest in graywater activities associated with evaporative cooling include Southern California Edison Company, the Western Cooling Efficiency Center at UC Davis, water treatment technology manufacturers, and evaporative equipment manufacturers such as ICI, Seeley, and Beutler Corporation. Southern California Edison Company is providing $275,000 to test water impacts on an evaporative condenser technology. Further work is needed to demonstrate the successful use of these graywater technologies.

Background: In homes, irrigation and toilet flushing are two common uses for graywater, but nearly any noncontact use such as evaporative cooling is a possibility. In most areas, outdoor irrigation is a seasonal use for graywater, but graywater is produced throughout the year. Toilet flushing can use considerable amounts of graywater, as it normally accounts for up to 50 percent of indoor water use. Poor quality graywater is not a problem if it is used to flush toilets because the water goes into the sewer or septic system, where it would have gone had it not been reused. Although this used water may contain grease, food particles, hair, and any number of other impurities, if handled properly, it may still be suitable for reuse.

Untreated graywater is suitable for irrigating lawns, trees, ornamentals, and food crops if applied directly to the soil, not through a sprinkler or any method that would allow contact

with the aboveground portion of the plants. Concerns arise when graywater is applied to root crops, which are eaten uncooked, plants that thrive only in acid soil because graywater is alkaline. Graywater should be dispersed over a large area and rotated with fresh water to avoid buildup of sodium salts.

With an automatic clothes washer, the wash water from a lightly soiled load, or rinse water, can be saved to wash the next load unless the laundry includes diapers, gasoline, diesel, or similar pollutants, unless only used for toilet flushing. Southern California Edison Company has been looking into evaporative cooling for more than a decade but was unsatisfied with past results. The utility found that standard swamp coolers left a high mineral content, which ultimately caused units to fail testing. Currently the utility is looking into better systems. This research initiative will complement past and current work.

S1.6 Proposed Funding Initiative: Develop Cost-Effective Retrofit Strategies to Achieve Greater Energy Efficiency in Existing Residential and Nonresidential Buildings.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Nearly 60 percent of California's housing stock (and a comparable percentage of California's commercial building stock) was built before the existence of Building Energy Efficiency Standards. Accordingly, substantial energy efficiency improvements are needed in many of California's existing buildings, particularly in multifamily residential and small and mid-size commercial buildings. However, many market and cost barriers prevent residential and commercial building energy retrofits. Foremost are the economic payback of energy retrofits, longevity of home ownership and the split incentives between renters and building owners. (For example, renters pay utility bills, and building owners do not.) Additional barriers include lack of knowledge and incentive by building owners and financial decision makers of the attributes of energy-efficient buildings, how to obtain a higher performance building, what resources (tools, models, and entities) are available to help building owners, how to assess cost-effectiveness of building retrofits, and how to obtain low-cost financing for retrofits.

Purpose: This initiative will develop new technologies and approaches for cost-effective energy efficiency retrofits and includes:

- Developing a roadmap for maximizing cost-effective energy efficiency retrofits in existing buildings.
- Identifying and demonstrating innovative technologies and approaches s to bring energy efficiency retrofits solutions to low-income residential builders/owners.
- Developing and demonstrating an integrated suite of cost-effective, advanced energy efficiency measures, tools, and strategies for enabling best practices for retrofit construction. This includes identifying the most cost-effective package of advanced heating, cooling, and ventilation, lighting, plug-load efficiencies, building envelopes, domestic hot water systems, building controls, and performance technologies for use in existing buildings in California climates including using simplified, low-cost tools that use satellite imaging rather than on-site audits, such as the Building Energy Asset Rating System (BEARS).
- Evaluating current issues that underlie the lack of available energy performance information for all types of decision makers in the building retrofit marketplace.

- Investigating and collaborating with others to institute common data collection and sharing protocols that can be instituted in all public and ratepayer-funded RD&D and other incentive and evaluation programs, to provide this much-needed performance information to all market actors
- Investigating the role of consumer behavior, particularly in multifamily buildings, to develop technologies and approaches for cost-effective strategies in the retrofit market.

This initiative will coordinate with other building energy efficiency initiatives to avoid duplication and capitalize on synergies.

Background: Existing building retrofits have occurred haphazardly. Utility rebate programs have focused on specific energy technologies, rather than whole-building approaches, and participation is limited. Energy audit programs typically are targeted at specific sectors or to organizations with a desire to upgrade or renovate. Often, energy renovations require a champion to push for improvements and identify energy and nonenergy benefits (for example, improved employee or student performance). Additionally, split incentives often deter any energy improvements since building owners often do not pay utility bills and reap the benefits from retrofits.

Assembly Bill 758, (Skinner, Chapter 470, Statutes of 2009) requires the Energy Commission to develop and implement a comprehensive program to achieve greater energy savings in the state's existing residential and nonresidential building stock. The program is composed of a complementary portfolio of techniques, applications, and practices that will achieve greater energy efficiency in existing residential and nonresidential structures, especially those that fall significantly below the efficiency required by the current *California Building Energy Efficiency Standards* (Title 24, Part 6). The program elements include meaningful and reliable building energy assessments, energy benchmarks, building energy use ratings and labels, cost-effective energy efficiency improvements, public and private sector energy efficiency financing, public outreach and education, and green workforce training. The bill directs the Energy Commission to consider these components when developing the program, as well as other factors and strategies that the Energy Commission deems appropriate. These improvements will result in major energy savings that are important to California's economy and environment, particularly due to the air quality and water resource impacts of power plants, energy bill impacts of unnecessary electricity and natural gas use, and California's efforts to address climate change through greenhouse gas (GHG) emission reductions.

S1.7 Proposed Funding Initiative: Reduce the Energy Use of Plug-Load Devices Through the Development of Products, Systems, and Controls, and Evaluation of Consumer Behavior That Affect Energy Use.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Plug loads are becoming an increasingly large share of residential and commercial building energy load. Current plug load trajectory is not on track to enable zero-net-energy buildings in California by 2020. More comprehensive and ambitious plug-load research, efficiency improvements, and policy action resulting in new Title 20 standards is needed to reach those goals. There are significant building design and operation issues with regard to plug loads. Behavior and occupancy are also a significant influence.

Purpose: This initiative will advance the development and deployment of more efficient consumer and office electronics while focusing on the integration of smart controls. The research will target efficiency improvements in existing and future plug-load devices, advise future Title 20 appliance standards, as applicable, and address behavioral and other issues. The efforts will complement other research being undertaken by UC Irvine and others. This research is anticipated to be supported by consumer/business equipment industry, utilities, and standard setting groups.

Background: Plug loads are devices that plug into electrical outlets (as opposed to being hard-wired), are not traditional appliances, and contain internal or external AC-DC power supplies. Energy use in the residential and commercial sectors in California for plug loads is one of the fastest growing energy loads, contributing about 15-20 percent of residential and 10-15 percent commercial electrical use, and this use could double by 2030. Some recent estimates by the U.S. DOE have put residential plug load, without intervention, at 40 percent by 2035. If plug-load energy use continues at this pace, it will prevent achievement of the state's net-zero-energy building goals.

Past research focused on external power supplies, office electronics, battery chargers, flat screen televisions, home stereo/audio systems, and 24/7 kiosks (for example, ATMs). The Commission's plug load research to date has been very successful and resulted in a projected annual savings of more than $1 billion through adoption of three Title 20 Standards. The UC Irvine's CalPlug Center is performing research on set-top boxes. This initiative will continue research into other plug load areas, such as improving computer efficiency, improving the

efficiency of small server rooms, understanding smart user controls and how to create a personal user energy footprint based on the collection of data from a variety of plug-load end uses collected in smart meters.

S1.8 Proposed Funding Initiative: Develop and Evaluate Ideal Strategies to Improve Indoor Air Quality in Energy-Efficient Buildings

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Indoor air pollution in California – not including tobacco smoke – has been attributed with around $11 billion per year in adverse health impacts, and another $9 billion has been attributed to lost productivity in office workers and teachers. The increased efficiency of new and existing buildings is resulting in tighter buildings that reduce air infiltration. As a result, indoor air quality is deteriorating**.** Use of new construction materials and products and increased use of recycled materials may result in increases of unknown emissions (such as semi-volatile organic compounds − SVOCs). Research is needed to identify the resulting indoor air quality and public health impacts and to develop cost-effective mitigation measures.

Purpose: This initiative will focus on research to characterize indoor air quality and develop cost- and energy-efficient air quality improvement methods.

Background: To help meet AB 32 goals, the Energy Commission is working with the California Public Utility Commission, California Air Resources Board, and various stakeholders to implement the *California Strategic Energy Efficiency Plan*. Past research has resulted in several landmark studies of indoor environmental quality (IEQ) and related factors in California, including studies of new residential buildings, small and medium commercial buildings, and pollutant emissions from office equipment. Current studies include retrofits of low-income apartments, exposure from unvented combustion appliances, and healthy zero-energy buildings. In addition, studies of building heating, ventilating, and air conditioning (HVAC) and air leakage that are pertinent to IEQ have been conducted.

ARB sponsors research on indoor air quality covering topics such as indoor and personal exposure, indoor-outdoor relationships, and toxic air contaminants. ARB has funded large indoor air quality field studies in homes and schools, as well as studies on emissions from indoor sources, building ventilation, and air cleaners.

The U.S. Environmental Protection Agency (EPA) Indoor Air Quality research focuses on improving techniques to measure and model emissions of indoor chemical contaminants present in a variety of structures (schools, office buildings, and homes) and to investigate a variety of approaches to ameliorate mold problems in residences and office buildings. In the late 1990s, the EPA completed the landmark Building Assessment, Survey, and Evaluation (BASE) study to determine the typical concentration distributions of a number of chemicals found in a representative sample of U.S. office buildings to correlate these pollutant levels with building parameters and occupant activities and symptoms. U.S. Department of Energy's (U.S. DOE) indoor air quality research and development focus on developing new ventilation strategies that simultaneously improve indoor air quality and reduce the energy impact of increased ventilation.

S1.9 Proposed Funding Initiative: Develop Cost-Effective Technologies and Approaches to Achieve California's Zero Net Energy Buildings

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Currently, there is no central repository of information or data that discusses the results of existing ZNE projects and the barriers that still must be overcome to reach the state's 2020 and 2030 goals for new residential and commercial buildings, respectively. Additionally, there has been little focus on ZNE buildings strategies for multifamily and small commercial buildings. Owners of these types of buildings have very little incentive to achieve ZNE when they do not pay utility bills. There are many examples of ZNE homes and ZNE commercial buildings that have been constructed. However, these buildings have noticeably higher first costs than traditional building designs, and this continues to be a barrier, despite various subsidies, tax incentives, and other financial incentives.

On the technical side, some of the single or combinations of emerging technologies have potential to maximize energy efficiency and reduce overall building and life-cycle costs. Some examples include dynamic windows, radiant heating and cooling, direct current lighting, and advanced innovative applications of thermal energy storage. These strategies have not been integrated into whole buildings and their performance measured. Climate-specific technologies and design practices also need to be developed to account for the wide variations in heating and cooling needs based on climate zone.

Purpose: This initiative will analyze the different technological paths to cost-effectively reach ZNE building goals. The research will include a roadmap showing the most cost-effective strategies and technologies for achieving the state goal for each sector (multifamily residential and commercial), and the most promising building type candidates. The roadmap will also include a review of existing projects in California, the barriers and issues that need to be addressed, and the needed research for meeting the state's ZNE policy goals, consistent with the *California Energy Efficiency Strategic Plan*. This initiative will include some integrated pilot-scale evaluation of measures most suitable for cost-effective deployment of ZNE buildings.

Background: The *California Energy Efficiency Strategic Plan* and the Energy Commission's *Integrated Energy Policy Report* have established ZNE goals for residential and commercial new and retrofit construction. To date, however, there have been limited ZNE buildings constructed and renovated in California.

San Diego County's research project "ZNE Affordable Multifamily Housing" demonstrated that with motivated local agencies, progressive developers, and a combination low-income tax credits, state rebates, and additional debt leveraged from energy cost savings, developers can fully cover the first cost of constructing a ZNE building. Thus ZNE or near ZNE is achievable in low-income multifamily buildings. This project also demonstrated that per-unit cost premiums could be minimized by using innovative integrated design principles and establishing clear project goals. The two apartment complexes that were the focus of the project generated almost as much energy (90 or more percent) as they drew from the electric grid. More work is necessary to replicate these types of results and overcome barriers in different climate zones and local jurisdictions.

In the project "Commercializing Zero Energy New Home Communities" (2010), the goals were to define innovative and cost-effective approaches in the areas of photovoltaic systems, energy efficiency product selection, and new home design and construction standards. In a development sitewide approach, three homebuilders built more than 270 ZNE homes in four demonstration communities, one of the buildings was a 46-unit multifamily building. The single-family homes exceeded existing Title 24 energy efficiency standards by 35 percent, and energy costs were 60-70 percent lower than comparably built non-ZNE housing. According to the builder, the premium for the homes with ZNE was minimal, and the ZNE homes sold much faster than similar homes without photovoltaic systems.

In a larger scale energy efficiency project titled *Energy-Efficient Community Development in California: Chula Vista* (2008), results of modeling 40 building types with various optimization of energy-efficient technologies were combined with renewables and some multibuilding heating and cooling strategies. The project models demonstrated the potential to reduce energy use by up to 43 percent and peak demand by 45 percent as compared to the Title 24-compliant project/development in place at the time. The modeling to determine the best combination of market-feasible technologies indicates that these technologies are building-specific. Results of

the financial, business, and policy analysis show that communities need new public and private sector management models to address barriers that currently impede adopting these building technologies and site features by the building industry. In-depth study and the development of solutions to these barriers are needed in future research.

The investor-owned utilities have had specific ratepayer-funded programs targeting construction of individual ZNE buildings and low and ZNE communities. Habitat for Humanity has built several zero-net–energy, single-family homes. Though there has been interest in ZNE building design, there is little information on what are the best approaches for meeting the ZNE goals of the different building sectors and types.

This initiative will develop a roadmap and capitalize on past efforts to identify the most effective strategy for achieving cost-efficient, zero-net-energy buildings in the various building sectors.

S2 Strategic Objective: Develop New Technologies and Applications That Enable Cost-Beneficial Customer-Side-of-the-Meter Energy Choices.

Table 3: Ratepayer Benefits Summary Table for Strategic Objective 2

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S2.1 Develop Cost-Effective Metering and Telemetry to Allow Customers with Demand Response, Distributed Generation, Plug In Electric Vehicles, and Energy Storage to Participate in California ISO Markets.	X	X		X	X			X	X
S2.2 Develop Demand Response Technologies and Strategies to Allow Customers to Participate in Ancillary Service Markets.	X	X			X			X	X
S2.3 Standardize Communication System Hardware and Protocols for Customer Premise and Neighborhood Area Networks.	X	X			X	X		X	X
S2.4 Lower the Customer Costs and Uncertainties of Interconnection of Customer-Side Resources Through Testing and Standardization.		X	X	X	X		X	X	X
S2.5 Develop and Test Novel Technologies, Strategies and Applications That Improve the Business Case for Customer-Side Storage.	X	X				X	X	X	X
S2.6 Demonstrate and Evaluate the Integration of Distributed Energy Storage at the Community Scale.	X	X			X	X	X	X	X

Customer participation in dynamic pricing and other programs allows customers to reduce their electricity demand and generate new income streams. Customer participation delivers value and cost savings to customers in multiple ways. Customers who own distributed resources including demand response, distributed storage, distributed generation, and plug-in

electric vehicles will have a new revenue stream by providing grid support such as ancillary services and voltage stability to address intermittent generation resources. In addition, greater customer participation in these programs will help utilities and grid operators reduce peak demand and integrate intermittent renewable while providing the benefits of a more reliable grid.

The following initiatives will address barriers and advance the technologies, applications, and strategies to enable and encourage customer-owned resources to participate in energy market programs that provide demand-side management.

S2.1 Proposed Funding Initiative: Develop Cost-Effective Metering and Telemetry to Allow Customers with Demand Response, Distributed Generation, Plug-in Electric Vehicles, and Energy Storage to Participate in California ISO Markets

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X			X

Issue: This research addresses barriers to cost-effective metering and telemetry. Telemetry refers to automatic measurement and transmission of data by wire, radio, or other means from remote sources to a distant receiver for recording and analysis. The costs of metering and telemetry are barriers to the use of renewable and combined heat and power (CHP) generation for ancillary services. Lowering these costs will increase the integration of a growing number of demand response (DR) capable systems with ancillary services.

Purpose: This initiative aims to reduce the cost of communication and telemetry technologies and improve automation for DR to allow more electricity customers to participate in dynamic ancillary services market. This will ease the addition of more renewable generation to the grid to help meet Renewables Portfolio Standard (RPS) goals and Governor Brown's Clean Energy Jobs Plan calling for 6500 MW of additional CHP.

Areas of research include developing less expensive metering and telemetry technologies, researching algorithms for the pricing of automated demand management, developing a control system to interface between customer and utility systems that will send and receive control signals and measure actual demand response provided, and exploring ways to reduce the cost of metering and telemetry for small generators of renewable energy and CHP.

Background: Today's controls do not widely use Internet-based connectivity, but this is beginning to change with the commercialization of the Open Automated Demand Response (OpenADR)[24] protocol. Web-based energy information systems controls using the OpenADR protocol have been demonstrated in a controlled test bed. These systems allow embedded diagnostics algorithms and analytics to evaluate wasted energy and assess low-energy control strategies. These systems can also track performance in DR events and help the customer see utility bill savings.

24 Open ADR is an open communications specification to automate demand response (DR). OpenADR facilitates reliable and cost-effective automation of both electricity price and system grid reliability signals for DR.

There has been excellent collaboration between control companies, utilities, and standards groups in adopting OpenADR. Advanced, fast-automated DR systems were demonstrated, but more research is needed to reduce telemetry costs. While there has been only limited funding from the U.S. DOE, its role is growing.

Historically, this work on DR systems has focused on large commercial and industrial customers but the technology is now being designed for small commercial and residential customers.

S2.2 Proposed Funding Initiative: Develop Demand Response Technologies and Strategies to Allow Customers to Participate in Ancillary Service Markets

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X			X

Issue: There are a lack of hardware, communications standards, and operational protocols to allow the participation of widely distributed resources in the California Independent System Operator (California ISO) ancillary services markets. As renewable generation adoption accelerates, its intermittent and variable output will affect grid stability and increase the need for ancillary services such as voltage regulation. Intermittent and variable renewable output also needs to be balanced with energy storage, including vehicle-to-grid (V2G) capabilities for plug-in electric vehicles (PEVs), and with demand response.

Homeowners and small and large businesses currently do not understand energy costs, demand charges, and DR programs. They must navigate a complex collection of information and options when deciding whether to participate in utility energy efficiency or DR programs.

A set of interoperable tools is needed to help with retrofit analysis, bill savings, control strategy analysis, and DR strategies. Today, each of these tools is separate. For example, information from the DR Quick Assessment tool used by utilities is not interoperable with other tools. In addition, DR and energy efficiency (EE) programs are not integrated. Customers need information databases, benchmarking tools, simulation models, and other platforms to provide actionable information to allow better adoption of building systems that operate with low costs, energy requirements, carbon emissions, and peak demand. These tools, systems, processes, and strategies must be integrated to work seamlessly and provide optimal demand-side management.

Another challenge is the lack of measurement and verification systems that provide owners with real-time information on how a retrofit, control strategy, or DR system is performing.

Purpose: Developing hardware, communications standards, and operational protocols to open the California ISO markets to a dramatically larger number of participants will increase grid operators' available resources and flexibility. There is a need for pilot trials of coordinated operation of distributed energy resources (DER) with other distribution equipment, such as voltage regulation equipment in volt/volt-ampere-reactive (VAR) management schemes. This research will enhance grid flexibility and cost-effectiveness and create new revenue streams for end-users through participation in California ISO markets. Interoperable tools and information systems will allow residential, commercial, and industrial building owners and operators to understand DR technologies and to reduce their electric bills, enable greater use of renewables, and shift peak demand.

Possible activities under this initiative will:

- Develop information and modeling tools to promote demand response technologies and practices.
- Provide common platforms and engines for energy information systems, interoperability in benchmarking and simulation tools, new construction design decision support, and analysis platforms for DR strategies.
- Provide automated control and decision analysis to help homeowners, facility managers, and others set their control systems to minimize energy, peak demand, and costs.
- Allow information from the building to be aggregated and dispatched in larger consolidated systems to provide DR that behaves like a grid-scale battery.
- Explore use of real-time energy measurement, cost analysis, and modeling to improve customer economics and minimize bills.
- Enable energy feedback systems that will allow people to see how much energy their end-use load is using and how much they are saving.

Background: New technologies and operating practices are constantly developing on the distribution system in response to increasing penetration of renewable energy generation. There is a need for coordination and research to maximize California ISO market participation. Interconnection standards and practices for distributed resources especially need updating in light of the capabilities of inverter-based systems to supply grid services such as low-voltage ride-through (LVRT), volt-VAR control, frequency regulation, and other ancillary services. There is also growing interest in microgrids on the customer side, which will require a re-assessment of regulations and utility operating practices. The required communications and data management systems will require specific security standards and protection measures.

For applications in buildings, there are a number of modeling tools in this area such as Simergy, EnergyPlus, Modelica, DRQAT, EnergyIQ, and CBE Indoor Environmental Benchmarking. The Universal Translator for PG&E is beginning to warehouse some new algorithms for building operations analysis but the scope is limited. Building Information Models are being developed for life cycle interoperability, but are only just starting to be used in practice. The innovation pipeline in this area links information technology with modelers and database systems. New interest from Silicon Valley suggests California could be a great contributor in the area of increased modeling and monitoring integration. The U.S. DOE is providing ongoing support for Modelica and EnergyPlus to improve building models for design, retrofit analysis, and operations analysis. The U.S. DOE is also considering investing in Open Energy Information Systems, which will support the commercially available OpenADR protocol. Many of these large platforms, cross-cutting information, and foundational tools go beyond the needs of individual customers to serve the needs of multiple customers and multiple sectors. Knowledge of these tools is needed for advanced low-energy design.

The use of Internet-based connectivity by today's controls is very limited. This is likely to change now that OpenADR is commercial and web-based energy information systems are available. Advanced controls for plug loads are emerging to help show how to turn off plug loads based on occupancy. However, many of these plug load controllers can be designed to integrate with Open ADR clients and also collect and display usage data to the end user. Many of these plug load controllers can be designed to act as OpenADR clients. It is critical, however, to integrate these systems, HVAC, plug load, and lighting into whole building platforms, which is technically feasible but expensive due to lack of interoperability. Optimized integration of these systems provides continuous commissioning and energy management to ensure that the savings continue after a building is commissioned.

S2.3 Proposed Funding Initiative: Standardize Communication System Hardware and Protocols for Customer Premise and Neighborhood Area Networks.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X			X

Issue: Most end-use systems cannot communicate with utility systems. Additionally, most customer-side network systems fail at adequately incorporating fault detection and diagnostics. The result is that customer side equipment is unable to communicate issues on its performance to gateways. There is a need to develop interoperable communications systems and hardware to

interface between customer and utility systems to send and receive control and pricing signals and to measure the demand response and ancillary services provided.

Purpose: Developing interoperable communications systems and hardware to interface between customer and utility systems will enable customer-side-of-the-meter programs and lower the costs of end-user interconnection and California ISO market participation. Interoperability and integration of systems will increase grid efficacy with a focus on customer-side-of-the-meter tactics. These customer side of the meter tactics include customer premise networks, gateways, building-scale storage, community-scale storage, smart single/three-phase inverters, end-use devises with multi-device communication capability, electric vehicle impacts, optimized smart meter functionality, and grid control system interfaces. This initiative will include pilots of distribution system communications as well as monitoring and coordinated operation of many types of actively controlled (smart) devices in the distribution system.

Background: New technologies and operating practices are constantly developing in the distribution system in response to increasing penetration of renewable energy generation. Communication protocols for various hardware and services are not necessarily designed to be forward-compatible or interoperable with future systems beyond the immediate requirements of the vendors producing them.

S2.4 Proposed Funding Initiative: Lower Customer Costs and Uncertainties of Interconnection of Customer-Side Resources Through Testing and Standardization.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	X

Issue: As renewable generation adoption increases, its intermittent and variable output affects grid stability and increases the need for customer-side systems such as energy storage, including vehicle-to-grid capabilities for PEVs, as well as demand response. Demonstrations of techniques to reduce the costs and uncertainties associated with integrating customer-side equipment are essential. There is a lack of hardware, communications standards, and operational protocols to allow the full use of widely distributed customer-side resources in the electric grid. Barriers include high costs, lack of standardization, and public perception and uncertainty.

Purpose: Demonstrating technologies and practices to reduce the costs and uncertainties of smart grid device interconnection is essential for utilities to make optimal use of emerging smart grid equipment and for the public to adopt it with the knowledge that it is safe and cost-

effective. This initiative calls for demonstrations of cost-saving hardware and practices to address the issues of smart grid device interconnection and for the rollout of equipment that allays customers' uncertainty about the safety of the devices. These demonstrations will eliminate barriers for the adoption and interconnection of smart grid equipment.

Background: New technologies and operating practices are constantly being developed in the distribution system both to increase functionality and flexibility and to respond to the increasing penetration of renewable energy. Customer-site hardware and communication protocols are not necessarily designed to be forward-compatible or interoperable with future systems beyond the immediate requirements of the vendors producing them. There is a need for coordination and demonstration of hardware to reduce the costs of interconnection to allow easier and more cost-effective integration of subsystem components that either do not yet exist or are not deployed to their full economic potential.

S2.5 Proposed Funding Initiative: Develop and Test Novel Technologies, Strategies and Applications That Improve the Business Case for Customer-Side Storage.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X					X	X

Issue: Current customer-side electricity storage is typically provided by batteries, which are large, expensive, and have limited capacity. In addition, the life expectancy of current batteries is short and replacement is costly. Past R&D has primarily focused on demonstration projects using existing technologies as opposed to developing new technologies or improving existing technologies. New technologies and strategies are needed to reduce the cost of storage for customer-side applications.

Purpose: This initiative will develop and test new technologies and applications to reduce the cost and improve the performance of customer-side storage. This initiative will conduct applied research and development in the following areas:

- Develop new technologies into working prototypes for pilot demonstrations: The U.S. DOE has provided significant funding over the last few years for basic research into advanced storage technologies. The Energy Commission will look for opportunities to address critical funding gaps to develop storage technologies into working prototypes, and demonstrate and evaluate the prototypes in pilot-scale applications.

- Demonstrate emerging or proven storage technologies in novel applications: There may be opportunities to reduce the costs of customer-side storage by integrating storage technologies with other technologies such as DR to create novel applications and strategies. For example, the Southeastern Pennsylvania Transportation Authority is using the same kind of braking technology found in hybrid vehicles – regenerative braking – to convert energy from braking trains into electricity and store it in a battery system for future use or for sale back to the grid in times of high demand. This initiative will investigate and demonstrate innovative applications and strategies that improve the business case for customer-side storage.

Background: Customer-side energy storage continues to remain a high priority for achieving the state's policy goals for the electricity sector. Over the past few years, the Energy Commission has provided more than $6 million in cost-share funds for various energy storage projects in California funded through the American Recovery and Reinvestment Act of 2009 (ARRA), along with $9 million to support several non-ARRA energy storage projects. Also, in 2011, the Energy Commission provided funding to install and integrate an advanced lithium-ion battery system at the Santa Rita jail in Alameda County. This storage system helps the jail reduce its electricity demand during summer peak to zero, allows the jail the potential to export energy, and provides congestion-reduction and improved reliability to the local distribution grid.

S2.6 Proposed Funding Initiative: Demonstrate and Evaluate the Integration of Distributed Energy Storage at the Community Scale.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X			X

Issue: Renewable generation makes up an increasing portion of the generation fleet. This generation tends to be more variable and intermittent, and does not have the system inertia for grid stabilization provided by conventional generation. This has increased the need for ancillary services, such as providing reactive power and voltage and frequency regulation. Energy storage can provide these services to integrate more renewable generation and stabilize the grid.

The high cost of most distributed energy storage systems is a primary barrier to market adoption. In addition, the needed characteristics of energy storage systems vary between clean energy resources when used for peak demand shifting. For example, peak generation from solar resources needs to be shifted only a few hours to coincide with peak demand times. Wind

energy, however, typically peaks at night and must be shifted further in time to match peak demand. Energy storage may provide the technological solutions to provide peak shaving. Furthermore, energy storage can be strategically deployed in the smart grid to maximize system reliability and provide voltage and frequency regulation where needed.

Methods and technologies to enable energy storage are needed to provide ancillary services that help the grid remain stable as more conventional baseload generation units are retired and as intermittent, variable renewable generation makes up a larger portion of the generation fleet.

Purpose: This initiative will develop and evaluate the integration of thermal and electric energy storage systems and applications to mitigate intermittency, increase the value of distributed renewable energy generation, and offset peak demand. Promising electric, thermal, and mechanical energy storage designs will be evaluated for their potential to mitigate the intermittency impacts of renewable energy generation and provide additional ancillary services in distributed settings. Evaluations will include the advantages and disadvantages of distributed electric storage systems at different sizes, scales, and locations and configurations.

EPIC investment will support the integration of electric storage technologies with other system components such as inverters, electric vehicle chargers, and other distributed energy resources. This will improve distributed generation performance and interoperability with smart grid components and will decrease energy storage costs.

This initiative will also advance thermal energy storage systems to increase the ability to cost-effectively shift the demand profile of buildings and communities and maximize the economic benefits of onsite electricity generation.

Background: The National Renewable Energy Laboratory recently developed a small commodity inverter for photovoltaics that can accommodate energy storage and has four-quadrant operational capability, which allows it to supply reactive power to the grid. There is also a demonstration at Los Angeles Air Force Base of electric vehicle-to-grid storage that can participate in the California ISO ancillary services market. These innovations can apply to different types of distributed energy storage and are examples of the type of technology that needs to be deployed and refined for the future grid.

Energy storage is an area with a wide breadth of beneficial uses and has accordingly received significant funding from a variety of sources, such as the U.S. DOE. Research is underway in California to evaluate the benefits of adding distributed energy storage in a high PV penetration residential community in several configurations.

Clean Generation

S3 Strategic Objective: Develop Innovative Technologies, Tools and Strategies to Improve the Affordability of Distributed Generation.

Table 4: Ratepayer Benefits Summary Table for Strategic Objective 3

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S3.1 Develop Innovative Technologies and Approaches to Improve the Performance of Combined Heat and Power Systems.	X	X		X	X		X	X	X
S3.2 Develop Innovative Technologies, Techniques, and Deployment Strategies to Accelerate the Commercialization of Sustainable Bioenergy Systems.		X		X	X		X	X	X
S3.3 Develop Advanced Distributed Photovoltaic Systems to Reduce the Cost of Energy, Increase Interoperability, and Advance Plug-and-Play Capabilities	X	X		X	X		X	X	X

Distributed generation (DG) – small-scale power generation located close to electricity loads – can reduce or eliminate the need to build new utility-scale generators, transmission, and distribution infrastructure. It can also improve the efficiency of the electric system by avoiding transmission and distribution losses that occur when electricity travels great distances over power lines to the distribution system. DG systems can also improve reliability by providing electricity and/or heat during grid outages. DG that delivers during peak demand periods can free up other generating capacity and ease transmission congestion.

The following initiatives aim to provide ratepayer benefits by reducing market barriers for DG systems, increasing the diversity of DG systems in the commercial market, and developing systems that provide direct benefits to electricity ratepayers. Furthermore, these initiatives will help advance the goals of Governor Brown's Clean Energy Jobs Plan, specifically the goals of

adding 12,000 MW of distributed renewables by 2020 and 6,500 MW of combined heat and power[25] (CHP) capacity in the next 20 years to California's energy generation portfolio.

The Energy Commission will evaluate innovative ideas to increase performance over existing DG technologies in the lab and use results to guide the development of advanced bench-scale prototypes. Technologies and strategies that show promise will move to pilot-scale demonstrations to evaluate market potential. Further applied research will be conducted to evaluate where and how technologies should be deployed to maximize the benefits to California electricity ratepayers.

S3.1 Proposed Funding Initiative: Develop Innovative Technologies and Approaches to Improve the Performance of Combined Heat and Power Systems.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		X

Issues: Upfront costs of installing CHP systems are a major barrier for many potential customers. Another major deterrent, particularly for reciprocating internal combustion engine systems, is the poor air emissions performance and inconsistent ability to cost-effectively achieve and sustain compliance with air emission standards. Advanced generation technologies such as microturbines and fuel cells emit less air pollutants but have other cost and operation-related barriers, some of which are discussed below.

CHP systems are also limited by the fact that they are sized for their thermal load, which sometimes results in excess electricity generation that does not provide additional value to the customer. The ability to match thermal load with potential end-use applications and customer-specific controls remains among the major technical issues. Other issues include the maintainability and durability of CHP systems, interconnection complexities (including telemetry requirements), and the flexibility to use alternative fuels and varying operational profiles. Compounding theses issues is the perceived risk and uncertainty by potential customers about owning such a system, as well as a lack of technical expertise to conduct operation and maintenance activities.

Purpose: This initiative will support applied research and development to advance the technical, economic and environmental performance of CHP systems – including combined

25 For the purposes of this objective, CHP includes combined cooling, heating, and power applications.

cooling, heating, and power (CCHP) – that operate on renewable fuels, fossil fuels, or both. The goal of research in this area is to reduce technology costs and improve system components through the following actions:

- Evaluate novel emission controls and strategies to meet air quality standards.
- Develop methods and strategies to improve prime mover performance and efficiency.
- Develop strategies and approaches to increase CHP market acceptance in industrial, commercial, and multi-family residential settings.

To promote wide acceptance of CHP and realize its full benefits to ratepayers, this initiative will investigate technological improvements and cost-effective and environmentally sound strategies for key CHP systems and prime movers. Potential focus areas will include, but not be limited to:

- Commercial CHP and CCHP systems that will provide cost-competitive and effective wide application of heat (such as thermally driven chillers for CCHP systems).
- Industrial cogeneration systems that are capable of using alternative fuels and integrating with energy storage.
- Advanced gas turbine cycles that will facilitate hybrid systems and the use of renewable fuels.
- CHP-enabling strategies that will address a range of fuel flexibility and technical and economic improvement for heat recovery technologies.

Background: CHP is an important energy generation technology that caters to all three priority actions under California's loading order. It is a proven technology for improving energy efficiency and when viewed as such, qualifies as first in the loading order. CHP represents about 12 percent of the online power generation capacity in California. A majority of this CHP capacity is powered by fossil fuels, with limited capacity from renewable resources. The many benefits provided by CHP systems include reduced energy costs, more efficient fuel use, fewer environmental impacts, improved reliability and power quality, locations near load centers, and support of utility transmission and distribution systems.

ICF International released a report that evaluates several scenarios for CHP deployment in California over 20 years. The analysis indicated that a 10 percent capital cost reduction is needed by 2030 to achieve the penetration modeled in the high-case scenario. Previous research examined the development of lower-cost, high-performance CHP systems. Current research projects will address the technical and operational requirements for integrating multiple DG and CHP technologies and enabling technologies and for DG/CHP systems with multiple fuel capabilities. Some specific areas targeted by current research include emerging approaches for reducing criteria pollutant emissions, expanding applications for use of exhaust heat for process

heating and cooling support, application of other exhaust components such as carbon dioxide from internal combustion engines, and strategies for co-fueling of natural gas and biogas. Additional research efforts will build on these emerging, emission-reduction and technology integration strategies, expanded potential applications, and other key project results to further reduce costs and enable further deployment of CHP and CCHP systems in California.

S3.2 Proposed Funding Initiative: Develop Innovative Technologies, Techniques, and Deployment Strategies to Accelerate the Commercialization of Sustainable Bioenergy Systems.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X				X		X

Issues: Biomass conversion technologies include thermochemical, biochemical, and physicochemical conversion processes. Physicochemical processes are mainly associated with the development of transportation biofuels. Thermochemical and biochemical processes are the dominant route for biomass electricity generation (or biopower) and are the focus of this discussion. Thermochemical conversion processes are expensive because of the low energy conversion efficiencies and the lack of full-scale deployment and require more research to drive down the costs and improve efficiency.

To ensure biopower is ecologically sustainable, California's biomass use policy limits harvest to feedstock derived as a secondary waste product or harvested from sustainable energy crops. Because biomass wastes are dispersed throughout the state, the cost to collect and transport the material significantly limits the feasibility of utility-scale bioenergy facilities. As diesel prices rise, the effective maximum radius for biomass collection sites decreases. Without innovative biomass handling systems that reduce biomass volume and improve energy content – such as densification and torrefaction – or biomass collection approaches – such as centralized biomass collection and distribution stations[26] - new biopower systems will only be economically sustainable at sizes of smaller than 10 MW. Additional research is also needed to develop data and best practices on the environmental and ecological effects of short-rotation energy crops, seasonal energy cropping systems, and other energy crop systems.

26 JDMT Consulting. http://www.energy.ca.gov/bioenergy_action_plan/documents/2010-12-14_workshop/comments/JDMT_Comments_TN-59368.pdf.

At small scales, internal combustion engines have been the most reliable generation technology. However, the equipment needed to control air pollution emissions on these devices can be relatively expensive because cost does not scale down with system size. Other generation technologies, like microturbines and fuel cells, have lower emissions profiles but are more costly and can be more complicated to operate. Research is needed to develop and test low-cost pollution controls for small generators and develop simple off-the shelf low-emission generation technologies.

Purpose: Through this initiative, research will advance the development of state-of-the-art biomass conversion technologies, low-emission generation systems, and fuel handling and processing systems. It will also include studies on how to reduce environmental impacts from harvesting and the supply of fuels. The goal of this initiative is to advance innovative approaches that show the greatest potential to reduce system costs and increase energy conversion efficiency. This initiative will conduct applied R&D in the following areas:

- Advanced Biomass-to-Energy Conversion Technologies: Biomass conversion technologies funded through this initiative include thermochemical and biochemical conversion technologies and approaches that can decrease production costs and/or otherwise increase the value of biogas. Innovative, lab-proven biomass conversion technologies and approaches should continue development into next generation prototypes to verify technical potential. Anaerobic digestion technologies will be examined for opportunities to reduce costs by increasing energy conversion efficiency and biogas production. Similarly, promising thermochemical technologies such as gasification, plasma arc gasification, and pyrolysis will continue to be developed and evaluated for reliability, conversion efficiency, cost-effectiveness, and environmental performance at the pilot scale.
- Improved Performance of Electricity Generators: To increase market acceptance of new conversion technologies, low-emission generation systems (including advanced pollution controls) will be developed and tested at pilot scale. To avoid duplication, biopower systems will be evaluated in coordination with other initiatives in this plan. Emissions profiles will be developed and made public on technology pairings with recommendations for future demonstration projects.
- Biomass Processing and Handling Systems: Through this initiative, research will investigate technologies and approaches to reduce the cost and environmental impacts of collecting and transporting biomass feedstocks over greater distances, and increase the technical and economical availability of biomass feedstock throughout the state. Additional research topics include development and testing of innovative strategies to reduce the cost of fuel processing and handling systems.

Background: This initiative will address challenges identified in the *2009 Integrated Energy Policy Report*, the *2011 Bioenergy Action Plan*, and the *Renewable Energy in California: Status and*

Issues report. This initiative also supports the biomass activities specifically identified in the EPIC decision.

Unlike other renewable energy resources, bioenergy technologies can provide reliable and renewable baseload generation, meaning that electricity can be generated during scheduled times and at pre-determined power levels. Some bioenergy technologies can also increase or decrease output based on the demand for power.

Biomass waste streams produced by California's commercial, agricultural, and industrial practices can be used as a fuel for combustion, or as a feedstock to produce biogas which can then be used to generate electricity. A number of emerging technologies and processes can be used to convert biomass into biogas (or producer gas), and each has its advantages and disadvantages. DG systems can then use the biogas to generate electricity. Bioenergy has many benefits compared to other forms of energy generation, including displacing fossil fuel power plants with a reliable renewable resource, generating distributed energy near demand, reducing greenhouse gas emissions, providing jobs in rural communities, providing agriculture, industry and forestry with an effective disposal option for biomass residues, and reducing wildfire severity and the use of landfills.

The U.S. DOE is current funding thermochemical research projects to develop conversion and upgrading technologies, focusing on the low temperature pyrolysis to bio-oil pathway. Current projects focus on enabling biorefineries to efficiently convert woody biomass into biofuels at demonstration and commercial scales.[27] The conversion technology research funded through this effort will be applicable to biopower systems.

Recent research efforts in California include preliminary evaluations of forest biomass conversion and the tradeoffs between power generation and biofuels production; economic and environmental analysis of dairy digester technologies; air quality implications of various conversion pathways and distributed generation technologies; and low-emission technologies to enable CHP production from biogas and landfill gas. EPIC investments will advance this knowledge base and build on recent project results, with particular focus on strategies to enable sustainable forest biomass collection and conversion, increase energy generation from agricultural waste streams, and develop low-cost emission control and advanced generation technologies to enable increased use of biomass in small-scale applications.

27 http://www1.eere.energy.gov/biomass/thermochemical_conversion.html.

S3.3 Proposed Funding Initiative: Develop Advanced Distributed Photovoltaic Systems to Reduce the Cost of Energy, Increase Interoperability, and Advance Plug-and-Play Capabilities.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		X

Issues: Current incentives for photovoltaic (PV) technologies are unsustainable over the long term and further cost reductions are necessary for PV to become cost competitive in California. While the cost of PV cells has decreased in recent years, the cost of other system components, such as inverters and racking systems, has not fallen quite as fast. Integrated, low-cost off-the-shelf systems need to be developed and brought to market to increase plug-and-play capabilities and interoperability of distributed PV systems with other distributed energy resources (DER).

As distributed PV penetration continues to increase on distribution feeders in California, a number of integration issues arise for utilities and grid operators. The approach several European countries have taken is to require all inverter-based PV to autonomously support volt-VAR and frequency management functions.[28] Currently, IEEE 1547 and California Rule 21[29] do not allow for the interconnection of these advanced inverter technologies. Further research is required to verify the reliable performance of PV systems with advanced inverter functionality and advise standards for the development of such systems.

Purpose: This initiative will develop next generation low-cost distributed PV systems and power electronics designed to work in concert with other DERs and smart grid components. This initiative will also support the development and evaluation of comprehensive approaches to reducing the cost of energy for PV, and investigating strategies and business models to ensure that commercial PV systems are readily available and provide the functionality needed for customers and the utility grid. The Energy Commission will evaluate PV systems that are easily and quickly deployable as well as technology advances and strategies to increase the value of distributed PV systems in energy smart communities. This initiative will conduct

28 http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/06%20Frances%20Cleveland%20-Xanthus%206-20-Advanced%20Inverter-based%20DER%20Functions%20-%20CEC%20Panel%20v2.pdf.

29 http://www.cpuc.ca.gov/PUC/energy/Procurement/LTPP/rule21.htm.

applied R&D to improve the economic performance of distributed PV, including, but not limited to:

- Advanced concentrating PV technologies and designs: To reduce costs and increase PV system performance, this initiative will develop and evaluate innovative concentrating PV systems, including concentrator designs, low-cost and high accuracy advanced tracker systems, system integrated inverters with advanced functionality, and strategies to use heat generated as a by-product of concentrating sunlight to increase system efficiencies. Concentrating PV systems use optical concentrators to focus incident radiation onto a small PV cell, generating heat. Typically, this heat is dissipated into the surrounding environment as waste, but there are several technologies that look to use this waste heat in useful CHP applications, thereby increasing the overall system efficiency.
- Low-cost building-integrated PV materials: This initiative will further reduce costs by developing building-integrated PV and hybrid solar systems that are fully integrated into building designs, including roofing surfaces, window materials, and/or other building elements. These systems should work in concert with other energy components within the building to advance California's zero net energy buildings goals. Applied research activities will also inform standards for the integration of PV systems into new residential and commercial buildings.
- Advanced PV inverter functionality and interoperability: This initiative will develop and evaluate smart PV inverter technologies that can autonomously monitor local grid conditions and respond accordingly. Inverter functionalities will include volt-VAR control, dynamic grid support during low-voltage ride through, remote communications, and power curtailment. Advanced inverter technologies and smart grid components will be developed and integrated into packaged PV systems to increase interoperability with other co-located DER including energy storage, electric vehicle chargers, and other smart grid resources enabling the development of energy smart communities and local microgrids. This initiative will support research to develop the abilities of PV systems to communicate with Local Area Networks to securely provide real-time system performance information to customers and utilities.
- Strategies to reduce non-hardware costs of PV: This initiative will develop and evaluate strategies to reduce the non-hardware costs for distributed PV across the entire value chain – including manufacturing, distribution, installation, operations, and end-of-life system considerations. The Energy Commission will identify any untapped opportunities for non-hardware cost reduction and investigate strategies to strengthen the business case for distributed PV systems in California.

Background: A significant research effort is underway at the federal level with the U.S. Department of Energy's SunShot Initiative, the aim of which is to reduce the cost of energy

generated from solar resources by 75 percent by 2020. As part of this effort, the U.S. DOE launched the Rooftop Solar Challenge to reduce non-hardware PV costs and improve market conditions for PV projects. This nationwide effort engages diverse teams of local and state governments along with utilities, installers, non-governmental organizations, and others to make solar energy more accessible and affordable.[30] The SunShot initiative presents a significant opportunity for California to leverage U.S. DOE funding while maintaining the state's track record of innovation and early adoption.

In recent years, several research projects have focused on ways to advance distributed PV technologies and California's PV industry as a whole. For example, SolarTech has looked at comprehensive ways to reduce the cost of solar energy through permitting, installation, and other "soft cost" reductions. Other projects have sought to reduce costs with innovative technology designs and low-cost installation strategies. While promising advances were made in these projects, further cost reduction opportunities exist that are essential to the long-term viability of distributed PV in California.

Going forward, the Energy Commission is in a position to complement the advances made with California Solar Initiative Research and Development investments, which will invest a total of roughly $50 million by 2016 to fund solar research and demonstration projects to measurably reduce the cost and accelerate the installation of solar. To date, two competitive grant solicitations have awarded $23 million to 17 projects to research high-penetration solar modeling, improved solar production technologies, innovative business models, and integrating PV systems with energy efficiency, demand response, and energy storage.[31] EPIC investments will be coordinated with the CSI R&D program to avoid duplication and leverage the results of projects funded by both programs.

The proposed IEEE 1547.8 update should allow higher penetrations of inverter-based DER, including PV, but it is still under development. The purpose of the update is to provide more flexibility in determining the design and processes used in expanding implementation strategies for interconnecting distributed resources with electric power systems.[32] Developing and deploying advanced inverter technologies will improve power system efficiency, delay the need for distribution upgrades, and help avoid grid outages. Inverter manufacturers are already including advanced functions for the European market, and lessons learned could be leveraged to develop optimized upgrades for California's environment. Results of applied research in this area could be used to advise any updates to California's Rule 21.

30 http://www.eere.energy.gov/solarchallenge/.

31 http://www.energy.ca.gov/2012_energypolicy/documents/2012-05-14_workshop/comments/2012-05-21_Itron_Inc_Comments_TN-65377.pdf.

32http://www.4thintegrationconference.com/downloads/Distribution%20Grid%20Codes%20Tutorial_PPL%20Electric_Bassett.pdf.

S4 Strategic Objective: Develop emerging utility-scale renewable energy generation technologies and strategies to increase power plant performance, reduce costs, and expand the resource base.

Table 5: Ratepayer Benefits Summary Table for Strategic Objective 4

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S4.1 Develop Advanced Utility-Scale Thermal Energy Storage Technologies to Improve Performance of Concentrating Solar Power.	X	X		X	X			X	X
S4.2 Develop Innovative Tools and Strategies to Increase Utility-Scale Renewable Energy Power Plant Performance and Reliability.	X	X		X	X			X	X
S4.3 Develop Advanced Technologies and Strategies to Improve the Cost-Effectiveness of Geothermal Energy Production.	X	X		X	X			X	X
S4.4 Investigate the Economic, Environmental and Technical Barriers to Offshore Wind in California.	X	X		X	X			X	X
S4.5 Investigate the Economic, Environmental and Technical Barriers to Wave Energy Conversion Technologies in California.	X	X		X	X			X	X

In response to the adoption of the 33 percent Renewables Portfolio Standard (RPS) and Governor Brown's Clean Energy Jobs Plan goal of deploying 8,000 MW of large-scale renewable energy systems by 2020, California has aggressively pursued greater reliance on renewable energy sources. As a result, the state leads the nation in electricity generation from non-hydroelectric renewable energy sources, including solar, wind, geothermal, and biopower generation. While gas-fired generation and nuclear power continue to play significant roles in the state's electricity system, the focus is on protecting the environment and creating jobs

through developing and integrating renewable energy sources. R&D initiatives identified in this objective will focus on utility- scale renewable energy sources, specifically solar, including PV and concentrating solar thermal, geothermal energy, and emerging offshore renewable technology opportunities.

The Energy Commission will fund research to improve the cost and performance of existing utility-scale clean energy generation, which is defined as a standalone generation facility that is directly connected to the grid and is 20 megawatts or greater in capacity. Research on clean energy generation will also be targeted at filling knowledge gaps and technology needs to deploy and integrate emerging utility-scale renewable energy technologies in a stable, secure, and environmentally friendly way. Research initiatives focus on system engineering in addition to developing data, technologies, and tools for planning and operating large renewable energy power plants that work with state, regional, and local transmission resources. Incremental improvements in technology, as well as innovative breakthroughs, will be sought through applied research in bench and pilot-scale developments.

Additionally, there is a need to invest in the development of promising utility-scale clean energy technologies and applications that have not yet reached commercial maturity. Two such emerging energy technologies that may be able to contribute to California's RPS goals are offshore wind and marine renewable energy. California has considerable electricity generation potential located in offshore resource areas, but has yet to develop the tools and technologies to cost-effectively take advantage of those resources.

S4.1 Proposed Funding Initiative: Develop Advanced Utility-Scale Thermal Energy Storage Technologies to Improve Performance of Concentrating Solar Power.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		X

Issue: Integrating thermal energy storage (TES), a means of storing thermal energy for later use, with concentrating solar power (CSP) plants allows generation during reduced or non-solar periods and dispatch when needed, reducing system variability and evening peak demand. The use of storage may increase annual capacity factors as well. The National Renewable Energy Laboratory [33] estimates that the use of TES may allow CSP plants to achieve annual capacity

33 NREL website: http://www.nrel.gov/csp/troughnet/thermal_energy_storage.html. Accessed August 23, 2012.

factors of up to 70 percent or more, a significant increase over CSP plants without thermal storage. CSP plants may then shift generation to higher priced periods. CSP plants integrated with TES can provide not only firm capacity but also high-value ancillary services such as spinning reserves.

There are currently several drawbacks to the use of TES systems, including additional costs and the need to oversize the solar field. Further research is needed to reduce the cost of TES and improve the properties of heat transfer fluids to maximize CSP plant performance.

Purpose: This initiative will support research to improve TES for CSP applications. This initiative will also seek research on storage media with improved thermal and physical properties and advanced heat transfer fluids for CSP plants, such as organic salts and molten metals. Research on heat transfer fluids for direct use in solar plant operation may be coupled with research under this initiative.

Background: A variety of different heat transfer fluids, which are used to transport heat to the power block, have also been used to assess energy storage potential in CSP plant operations.TES has been demonstrated with a number of alternative heat transfer materials, such as petroleum-based products and molten salt. TES using molten salt storage seems to hold the greatest promise of economic commercialization. Molten salt systems, usually a mixture of 60 percent sodium nitrate and 40 percent potassium nitrate, allow the solar field to operate at higher temperatures relative to other fluids or storage media, returning as much as 93 percent of the energy sent into storage. Storage capacities from 3-12 equivalent full load hours have so far been evaluated.

The U.S. DOE has funded research on thermal energy storage through the SunShot Initiative. In 2008, the U.S. DOE SunShot Initiative funded 15 projects looking at Advanced Heat Transfer Fluids and Novel Thermal Storage Concepts for Concentrating Solar Power Generation for around $67.6 million. TES topics addressed by these projects included the use of molten salt carbon nanotubes, the use of CO_2 as the heat transfer fluid, and using solid ceramics for the energy storage vessels. In August 2012, the U.S. DOE announced new investments totaling $10 million for two university-led projects to advance innovative CSP system technologies. One of these awards was for a collaborative research team including University of California, Los Angeles and University of California, Berkeley to investigate liquid metals as potential heat transfer fluids with the ability to withstand higher temperatures.

KEMA is conducting research on thermodynamic modeling of different solar generation-thermal storage configurations to identify optimal approaches for dispatch applications. In 2011, KEMA began to evaluate the economic potential of CSP plants integrated with TES and develop models to examine the relative performance of a variety of TES technologies for CSP plant applications. Future Energy Commission work should expand this effort to include emerging TES technologies and configurations.

S4.2 Proposed Funding Initiative: Develop Innovative Tools and Strategies to Increase Utility-Scale Renewable Energy Power Plant Performance and Reliability.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		X

Issue: Both solar PV and CSP technologies present challenges to operation of the power system due to the variability and uncertainty of their generation output. Specific technical concerns related to intermittency involve grid stability, voltage regulation, and power quality (voltage rises, sags, flickers, and frequency fluctuations).

As there is a relatively small amount of installed solar capacity, the characteristics of solar technology (PV and CSP) power output are not well established. Initial experience with PV indicates that output can vary more rapidly than wind unless aggregated over a large area. There is also a need for modeling to smooth regional variations in generation, reducing the need for highly accurate forecasts. To facilitate utility-scale solar generation integration into the grid there is a need for improved forecasts to inform grid operators of upcoming variability in generation as well as the ability to smooth regional generation variability.

Purpose: This initiative will support research solutions to improve intermittent renewable energy integration into the state's electrical grid through developing improved forecasting and modeling tools. To enable the integration of increasing amounts of utility-scale solar generation into the grid, research under this initiative will develop and evaluate improved forecasting techniques and tools to inform grid operators of expected power plant performance on minutes-ahead, hours-ahead, and days-ahead timescales.

Expanding on past efforts, the suite of existing solar forecasting tools and models should be integrated and developed into a best-mix forecast tool for grid operators to incorporate into planning processes and dynamic operation of the grid. This initiative will also develop advanced modeling techniques and real-time resource assessments to smooth regional variation in generation, reducing the need for increasingly accurate forecasts.

Background: Research has been conducted to develop solar energy forecasting and monitoring tools for a spectrum of timescales, from minutes ahead to hours ahead to days ahead. There are several distinct forecasting techniques that each provides more accurate forecasts within certain timeframes, including total sky imagers for minutes ahead, satellite-based cloud vector analysis

for hours ahead, and numerical weather prediction models for days ahead. Recent research is evaluating the feasibility of integrating these three distinct tools into one seamless forecasting tool. Future research activities should build from these efforts and support the pilot demonstration of an integrated forecasting tool in the California ISO planning, such as the one described below. The California ISO[34] calls for improved day-ahead forecasting through numerical weather models with a focus on marine layer clouds. This can be achieved through developing advanced algorithms to ingest satellite and ground measurements to model for cloud cover as well as developing tools to select forecast models based on meteorological conditions.

The University of California, San Diego has performed extensive R&D in this area, particularly in shorter timeframe forecasting techniques and predicting the onset of localized weather events such as marine layers. Other private entities, such as Clean Power Research and AWS Truepower, have performed Energy Commission-sponsored forecasting research in collaboration with the California ISO. Further research is needed to integrate each separate approach into a best-mix tool that provides accurate forecasts of solar plant output across each timescale.

The U.S. DOE SunShot Initiative and CSI RD&D program have both supported research into forecasting for solar generation. EPIC investments will be coordinated with these and other programs to avoid duplication and leverage project results from these programs.

S4.3 Proposed Funding Initiative: Develop Advanced Technologies and Strategies to Improve the Cost-Effectiveness of Geothermal Energy Production.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X					X		X

Issues: Challenges to increased geothermal development stem from the fact that exploration and resource characterization activities are expensive and time consuming, and therefore necessitate long lead times for project development. Permitting and environmental considerations, such as emission of toxic air pollutants or possible impacts to water resources,

34 California ISO Research Topic Area Comment on EPIC Investment Plan TN-66713. Submitted August 16, 2012.

are also major barriers. Exploration, drilling, and resource development activities can account for roughly half of the capital costs associated with construction and operation of a geothermal power plant. Consequently, improvements in exploration and drilling technologies and resource assessment capabilities may hold the greatest potential for geothermal power plant cost reductions.

Purpose: This initiative will research improvements to geothermal resource characterization and development tools and analytical techniques to help reduce risks associated with development of a variety of geothermal systems, including hydrothermal, enhanced, and geopressurized systems. An area for advancement includes developing exploration and characterization tools to locate and characterize low- and moderate-temperature hydrothermal systems prior to drilling, thereby reducing well field costs. Research activities will also address downhole, high-temperature tools and electronics to improve geothermal subsurface operations, as well as improved drilling mechanisms, such as steering technologies. Ensuring reservoir productivity is also a priority so the initiative will also research refinements to the techniques and modeling tools needed to quantify production and injection impacts on geothermal reservoirs. Alternative working fluids for hot, dry rock resources, such as CO_2, will also be addressed. Lastly, the initiative will address research to improve existing geothermal plant efficiency, reduce corrosion and scaling, recover useable metals from spent geothermal brine, and improve cooling technology.

Background: The U.S. DOE's Geothermal Technologies Program conducts in-house research on exploration, characterization and development tools for enhanced geothermal systems, including high temperature tools and sensors, advanced drilling systems for enhanced geothermal systems, resource characterization and validation studies, and research on geothermal water use. Forty-six research projects have been funded in California through different U.S. DOE solicitations. EPIC geothermal research can use and build upon these federally supported research efforts to help improve and support California-specific geothermal research.

The Energy Commission also administers geothermal R&D funds under the Geothermal Grant and Loan Program, which is funded by the state's Geothermal Resources Development Account (GRDA). The objective of the Geothermal Grant and Loan Program is to promote planning and development of new or existing geothermal resources and technologies in California; however certain research activities are not eligible for funding under this program. EPIC funding will be used to complement California's existing geothermal research projects and leverage geothermal development funding opportunities from the U.S. DOE.

S4.4 Proposed Funding Initiative: Investigate the Economic, Environmental and Technical Barriers to Offshore Wind in California.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	

Issues: There are number of remaining barriers that need to be further investigated before offshore wind can be developed in California. The average water depth on the West Coast increases far more rapidly than most other coastal regions in the United States, which means that the highest quality wind resources are located in deep water. While shallow water offshore wind technologies are being developed rapidly in Europe, additional research is needed to address concerns of offshore wind in California's unique marine environment.

Environmental concerns are potentially a major barrier to offshore wind energy development. For example, good potential offshore wind resources may be in the migration path of sea mammals and birds, increasing the risk of collision with turbine blades. Noise and vibration from construction and operation of the wind turbine may also disrupt marine species' behavior.

Some of the technology advancements needed for deepwater offshore wind include larger capacity turbines and innovative integrated turbine configurations (rotor, drivetrain, tower, controls) to counterbalance their additional capital cost. To increase wind turbine capacity, weight needs to be reduced by developing innovative blade designs and lighter weight composite materials. Construction and operation costs can be reduced by simplifying installation and reducing maintenance requirements. Further analysis is needed to evaluate economic and technical feasibility and any additional technology advancements that will be needed.

Purpose: This initiative will evaluate the costs, environmental concerns, and technology needs for offshore wind energy systems in California, including the underwater transmission infrastructure necessary to connect with California's electricity grid. Research activities will identify the specific benefits, disadvantages, and trade-offs of offshore wind technologies, which could lead to future demonstrations in California.

Potential applied research topics include, but are not limited to:

- Evaluation of environmental and societal impacts.
- Evaluation of floating platforms and innovative component designs to minimize costs.

- Identification of priority locations to site offshore wind installations.
- Development of modeling tools to evaluating installation configurations.
- Evaluate grid integration impacts of offshore wind energy.
- Evaluation strategies to develop California's offshore wind supply chain.

Background: The U.S. DOE's National Renewable Energy Laboratory has been conducting in-house research on offshore wind for nearly a decade. The program is focused on improved resource characterization, grid integration, and standards development. The U.S. DOE also funded $20 million of research in 2011 to explore technology development and removing market barriers. More recently, funding opportunities were announced to demonstrate emerging offshore wind energy systems in United States waters, including the U.S. DOE Offshore Wind: Advanced Technology Demonstration Projects.[35] This grant opportunity provides funding for two topics: pilot-scale deployment and assessment of commercial viability.[36] Multiple proposals were submitted for demonstration projects in California, but awards have yet to be announced. While no offshore wind projects have been demonstrated in California waters, interest in developing these resources has recently increased.

S4.5 Proposed Funding Initiative: Investigate the Economic, Environmental and Technical Barriers to Wave Energy Conversion Technologies in California.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	

Issues: Currently, the estimated costs to purchase, install, maintain, and operate wave energy converter systems in California and the underwater transmission infrastructure necessary to connect them to the grid far exceed those of fossil fuel generation and other renewable resources. Compounding the cost issue are concerns about the effects that marine renewable energy technologies may have on marine animals and benthic (sea bed) ecosystems.

35 http://www1.eere.energy.gov/wind/financial_opps_detail.html?sol_id=473.

36 Andris Abele, Ethan Elkind, Jessica Intrator, Byron Washom, et al (University of California, Berkeley School of Law; University of California, Los Angeles; and University of California, San Diego) 2011, *2020 Strategic Analysis of Energy Storage in California*, California Energy Commission. Publication Number: CEC-500-2011-047.

The potential environmental impacts of marine renewable energy include dangers to marine life from working fluid leakage, electromagnetic fields, sounds and vibrations produced during electricity generation, and the impacts of erosion and sediment flows on natural coastal processes. These environmental compliance issues require significant attention before a demonstration project is possible in California.

Purpose: This initiative will investigate the environmental, economic, and technical issues with marine renewable energy technologies, including underwater transmission and substations. Technologies will be evaluated for their cost, reliability, and environmental performance in California's waters. Integration issues surrounding deployment of these marine energy technologies will be addressed along with the research to explore the potential environmental impacts of offshore renewable energy deployment.

Background: A large variety of wave energy converter technologies have been tested and demonstrated in other states and in Europe with varying degrees of success. Attenuators, point absorbers (power buoys), oscillating water columns, and multi-point absorbers are just a few of the wave energy converter technology types that have emerged over the last several years.

Previously, PG&E had proposed several wave energy demonstration projects off the Northern and Central California coasts with its WaveConnect program. These demonstration projects would have included four different wave energy technologies and generated 5 MW of grid connected electricity. PG&E opted to discontinue the project because of development and operation costs in excess of what they were willing to spend on unproven technologies.

The U.S. DOE Wind and Water Power Program supports R&D on a wide range of advanced marine renewable energy technologies, with the objective of better understanding their potential for energy generation, and identifying and addressing the technical and nontechnical barriers to their application and deployment, through programs such as the Marine and Hydrokinetic Technology Readiness Advancement initiative.[37] Specific activities addressed by the U.S. DOE in recent years have included component and device development, device testing, national marine renewable energy testing centers, array design, development, modeling and testing, and technology evaluation. This broad range of activities has resulted in a number of R&D funding opportunities that have not yet been fully leveraged by California's R&D funding agencies, including the Energy Commission.

Most recently, Ocean Power Technologies, a wave energy device developer, announced that it has received approval from the U.S. Federal Energy Regulatory Commission (FERC) for a planned 1.5 megawatt wave energy installation off the coast of Oregon. This is the first FERC license for a commercial wave power facility issued in the United States. The license provides a regulatory approval for the deployment of up to 10 wave energy converter devices.

37 https://www.fedconnect.net/FedConnect/?doc=DE-FOA-0000293&agency=DOE.

S5 Strategic Objective: Reduce the Environmental and Public Health Impacts of Electricity Generation and Make the Electricity System Less Vulnerable to Climate Impacts.

Table 6: Ratepayer Benefits Summary Table for Strategic Objective 5

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S5.1 Air Quality Research to Address Environmental and Public Health Effects of Conventional and Renewable Energy and to Facilitate Renewable Energy Deployment.			X	X					
S5.2 Research on Sensitive Species and Habitats to Inform Renewable Energy Planning and Deployment.			X	X					
S5.3 Develop Analytical Tools and Technologies to Reduce Energy Stresses on Aquatic Resources Water and Improve Water-Energy Management.	X		X	X					
S5.4 Develop Analytical Tools and Technologies to Plan for and Minimize the Impacts of Climate Change on the Electricity System.	X		X	X					

As California moves towards achieving a 33 percent Renewables Portfolio Standard and the greenhouse gas reduction goals of the Global Warming Solutions Act, the state must balance the need for renewable energy development with appropriate levels of environmental protection. Lack of suitable information and tools has emerged as a major source of uncertainty and delay in the permitting and deployment of renewable energy projects. This is readily apparent in the Southern California desert where traditional approaches to avoiding and mitigating environmental impacts of proposed solar projects have proved inadequate. Furthermore, the state's existing electricity system continues to contribute to the overall degradation of land, air and water resources while adversely affecting public health.

The environmental costs and benefits of renewable energy policies, conventional and emerging energy technologies, and system performance in achieving the state's RPS and greenhouse gas

emission goals must be understood to give decision makers the tools and information they need to balance environmental protection and energy development.

The initiatives under this strategic objective address research on air quality, habitat protection, and water resources associated with the existing electricity generation systems, including fossil fuel and renewable energy sources. Most public health research will be addressed under the air quality research initiative. Research under this initiative will also assess environmental issues associated with emerging renewable energy technologies, the interaction of climate change with the electricity system, and the electricity system's future evolution.

S5.1 Strategic Initiative: Air Quality Research to Address Environmental and Public Health Effects of Conventional and Renewable Energy and to Facilitate Renewable Energy Deployment.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		

Issue: The emphasis on adding renewable generation to the California energy mix has not replaced the requirement for new natural gas power plants. There is a need to understand how the new energy system will function and affect air quality. Also, there is a need to identify new sources of air pollution offset credits because credit scarcity is affecting the ability to site new plants where they are needed. It will also be critical for California to understand the potential air quality impacts of new generation technologies and fuels – as well as control technologies and mitigation strategies – as the state strives to meet its renewable energy and greenhouse gas emission reduction goals. This challenge is especially true for biopower, which faces major siting and permitting challenges due its potential air quality impacts. At the same time, the electrification of some energy services (for example, transportation and water heating) can be a tool to improve air quality conditions in California. Emissions inventories and assessments of the spatial distribution of emissions from biopower generation are needed to evaluate potential air quality benefits/impacts.

The *2012 Bioenergy Action Plan* identifies the need for additional R&D to ensure that energy production is environmentally and economically sustainable. Because biopower produces air pollution emissions of ozone precursors and particulate matter in each phase of development – from feedstock collection, transportation and processing to generation – compliance with air quality standards may be a major factor in bioenergy siting. Emission factors for certain

technologies and feedstocks are incomplete and need further research. Bioenergy gasification presents another area in need of research because emissions from bioenergy gasification and combustion vary significantly based on the feedstock source and the gasification technology.

Purpose: This initiative will evaluate air quality impacts of the current electricity system, which is predominantly natural gas-fired generation, including how to address the shortage of pollutant offsets for new generation. Air quality research will also focus on new generation technologies and fuels for electricity generation. The research will inform improved emissions estimates for technologies and fuels being considered for electricity generation in California and improved emissions mitigation strategies.

Public health research will focus on short-term dispersion modeling to inform understanding of pollution exposure in disadvantaged communities located near electricity generating facilities. Air quality research will also investigate the formation, composition, measurement, and population exposure to particulate matter, particularly ultrafine particulate matter (less than 100 nanometers in size).

Background: The California Air Resources Board (ARB) has sponsored more than 245 research projects on public health effects of air quality and sources, controls, and inventories of air pollutants. Coordinating with the ARB, local air districts, and stakeholders, the Energy Commission has focused on developing new test methods, instruments, and tools capable of measuring emissions from small and large generation sources and predicting both local and regional air quality impacts. It is supporting research on the air quality issues related to biogas from anaerobic digestion of food waste, the air quality impacts of implementing the RPS, and economically and environmentally viable strategies for conversion of bioresources to power. Other organizations such as the U.S. EPA and the New York Energy State Research and Development Authority have conducted similar research on ozone and particulate matter health effects, but additional research is needed specific to California.

S5.2 Proposed Funding Initiative: Research on Sensitive Species and Habitats to Inform Renewable Energy Planning and Deployment.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		

Issues: Increasing renewable energy production can yield numerous environmental and societal benefits by reducing greenhouse gas emissions and dependence on fossil fuels;

however, developers must carefully identify locations for energy projects to avoid unnecessary damage to California's vulnerable species and habitats. Utility-scale renewable energy offers significant challenges to balancing environmental protection with energy development due to the large land footprint of such projects.

A lack of baseline data, tools, and methodologies to assess and mitigate the interactions of species and habitats with renewable energy creates uncertainty and delays and increases the costs of permitting. A lack of shared information on the effects of renewable energy siting and deployment on wildlife species has created significant challenges for utility-scale solar development in southeastern California. Resource assessment and impact determination is difficult due to the lack of experience, information regarding how to adequately assess species distribution over square miles of desert, knowledge on population dynamics, and knowledge of species sensitivity to disturbance. This problem is exacerbated by a lack of proven mitigation measures and strategies. This issue, however, is not unique to large scale solar projects, but also applies to other large-scale renewable energy sources such as wind farms, transmission lines and forest biomass harvesting. Species and habitat considerations have also been major barriers to siting and deployment of other renewable energy technologies, including biomass and geothermal energy. There is a need for information and tools to not only to facilitate the permitting process for these renewable energy technologies but also to ensure environmental protection through developing, enhancing, and validating mitigation measures.

Bird and bat collisions with wind turbines are another example of environmental concerns that are a major challenge for siting wind energy projects throughout the state. In particular, a lack of information regarding the population status and viability of the Golden Eagle has led to a cessation of take permits necessary for project development in the Desert Renewable Energy Conservation Plan (DRECP).

Large-scale biomass cultivation and harvesting in agricultural and forested areas may adversely affect wildlife species. Agricultural areas within the state support sensitive species, such as the Swainson's hawk, that may be displaced if new agricultural crops for biomass production are introduced. Wildlife responses to forest biomass harvesting vary from species to species, but more information is needed to understand how each species will respond to different harvesting techniques and how to conduct harvesting sustainably.

Purpose: The intent of this initiative is to develop tools, technologies, and information that will help reduce, resolve, and anticipate environmental barriers to renewable energy deployment in California. Research on fossil fuel generation will also be addressed under this initiative. The emphasis of this initiative will be on resolving scientific data gaps and developing analytical tools related to sensitive terrestrial species and habitats to reduce delay and uncertainty in the siting process for energy facilities. Potential research topics include developing and testing innovative species mitigation strategies, building habitat suitability models and

planning/management tools, and improving impact assessment protocols and scientific baselines.

Research under this initiative will also inform planning efforts such as the Desert Renewable Energy Plan to ensure environmental barriers to future energy deployment are proactively anticipated, reduced, or resolved.

Background: While a significant amount of research on the state's biological resources has been conducted, very little of this work has focused on applied research to address the environmental effects of electricity generation. Examples of research to inform the permitting process for energy development in California include efforts by the California Wind Energy Association, the U.S. Forest Service, and others to address avian and bat interactions with wind turbines; the U.S. Forest Service is addressing the effects of collecting forest biomass on song birds and small mammals; and the University of Redlands is developing a decision support tool for assessing and mitigating impacts to Desert tortoises.

Around 9 current projects are addressing research to facilitate renewable energy siting and planning in the Desert Renewable Energy Conservation Plan (DRECP), as identified in the *2009 Integrated Energy Policy Report*. The DRECP will guide renewable energy siting and conservation in the Mojave Desert and Colorado Desert of California and is being developed by the Renewable Energy Action Team made up of the Energy Commission, California Department of Fish and Game (DFG), the U.S. Fish and Wildlife Service, and the Bureau of Land Management. These agencies, along with universities and other environmental stakeholders such as the Nature Conservancy, have recently invested in targeted research to facilitate the DRECP. For example, in 2011 at least $1 million in federal funding was provided to the DFG for endangered species research related to the DRECP.

S5.3 Proposed Funding Initiative: Develop Analytical Tools and Technologies to Reduce Energy Stresses on Aquatic Resources and Improve Water-Energy Management.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		

Issues: Water is closely intertwined with the state's electricity system. Not only is electricity used to pump, treat, and dispose of water, but water is used in electricity generation as well.

The most obvious example of this is hydropower where flowing water is used to generate electricity, but water is integral to many other generating processes as well.

As California's electricity system evolves to meet the state's renewable energy and greenhouse gas emission goals, it is important to reduce electricity's demand for water given that scarce freshwater resources may be a barrier to greater penetration of certain renewable energy technologies like concentrating solar power, geothermal, and biomass.

Opportunities for construction of new hydroelectric plants are extremely limited in California. Most economically viable sites have already been taken and development of remaining suitable sites faces significant barriers. Because hydropower plays a significant role in the state's electricity system, there are significant opportunities from improved forecasting and decision support tools as well as an improved understanding of meteorological processes that affect precipitation patterns, runoff and hydropower generation.

As identified in the *2005 Integrated Energy Policy Report*, there is a need for research to reduce the effects of hydropower generation on California's aquatic ecosystems. California's inland fish populations have steeply declined, in part due to hydropower generation. As existing non-federal hydropower facilities are relicensed by the Federal Energy Regulatory Commission, there is a need for research to inform this permitting process.

Environmental concerns may also pose significant permitting issues for emerging marine renewable energy technologies such as wave energy devices or offshore wind. Wave energy devices may change near-shore sediment transport, adversely affecting near-shore benthic (sea bottom) communities. Fish are anticipated to use wave energy conversion installations as artificial habitat, so sound and electromagnetic fields from the technology may affect their behavior. Large arrays of wave energy devices may block migratory marine mammal migration routes. Offshore wind anchoring devices may also block migrating marine mammals and cause bird and bat collisions with the wind turbines. It is important that these environmental effects be assessed and, where needed, be avoided, resolved, or reduced prior to commercial deployment of these emerging technologies.

Purpose: This initiative will develop tools, technologies, and information to inform the permitting and deployment process to help improve water and energy management. For example, there is a need to improve understanding of meteorological processes to increase the ability to forecast precipitation and runoff for hydropower generation. There is also a need to develop innovative forecasting techniques, such as for high elevation hydropower which represents about a third of in-state hydropower generating capacity. For example, the Hydrologic Research Center has demonstrated at five low elevation multi-purpose reservoirs in Northern California the usefulness of probabilistic runoff forecasts to improve hydropower generation and water management. This initiative would support such an application to high elevation hydropower projects.

This initiative will also support research to help reduce the impacts of electricity generation, especially hydropower generation, on aquatic species and habitats as well. Three thousand megawatts of non-federal hydropower generation in the state will be up for relicensing by the Federal Energy Regulatory Commission within the next ten years. Since these licenses are for thirty to fifty years, it is critical that the necessary tools and information be developed to inform this permitting process.

This initiative will also support research to reduce water demands from the electricity-generating sector. A major source of water consumption from fossil fuel and renewable generation is the water used for steam condensation, commonly referred to as power plant cooling. While there is water conserving cooling technologies available, such as an air-cooled condenser, which reduces water demand for cooling to zero, there are cost and performance penalties associated with their use. There is also a need for research to inform future renewable energy siting for offshore wind and wave technologies. Under this initiative, ecological information, tools and methodologies will be developed to proactively determine potential environmental impacts prior to full-scale deployment of offshore wind or wave energy conversion technologies.

Background: The U.S. DOE, the Electric Power Research Institute and others have conducted research on ways to reduce water demand from electricity generation, specifically through the use of air-cooled condensers or the use of water sources not suitable for agricultural or municipal uses. Research on air-cooled condensers has sought ways to reduce the heat and wind effects on condensers while degraded water research addressed the challenges of using such water from different sources in power plant cooling towers. Research by John Maulbetsch and the University of California, Davis are assessing the best use of wind barriers to reduce wind effects on air-cooled condensers.

The University of California, Davis, the U.S. Forest Service, Garcia and Associates and other conducted research on the effects of hydropower ramping flows on aquatic ecosystems. H.T. Harvey and Associates has conducted an environmental knowledge gap analysis for wave energy development in California.

S5.4 Proposed Funding Initiative: Develop Analytical Tools and Technologies to Plan for and Minimize the Impacts of Climate Change on the Electricity System.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		

Issues: Recent research has shown that over the next few decades the electricity system is highly vulnerable to climate change and extreme events. The information generated so far, however, has been designed to estimate the seriousness of the impacts and has looked mostly at what would happen by the second half of this century. The rapid evolution of the energy system must also be taken into account given the ambitious greenhouse gas (GHG) reduction goals adopted in California. This evolution should be guided with information that facilitates the creation of a more climate-resilient energy system. It is unlikely that programs other than EPIC would be able to generate the scientific and engineering information needed to create a more resilient electricity system in California.

Purpose: This initiative will produce practical information on GHG mitigation, impacts, and adaptation that informs policy deliberations at the CPUC, Energy Commission, and other jurisdictions. The main focus will be on mitigation, impacts, and adaptation options for the next few decades since that is the timeframe used to develop energy policy.

To better assess potential climate change effects on the state's energy system, this initiative will improve climate change projections for California. Current climate change projections focus on temperature and precipitation with a very crude treatment of important variables such as wind and solar radiation. The proposed new research will improve the simulation of wind, ground-level solar radiation, relative humidity, and other parameters of importance to the energy sector.

This initiative will also improve the depiction of high elevation hydropower units in water models under different climate scenarios. Current simulations only address low elevation hydropower units. Including high elevation hydropower units is essential because research shows that climate change would cause high levels of spillage from high elevation hydropower units during the late part of the winter season, creating water management problems for low elevation reservoirs and their associated hydropower units.

This initiative will also address the energy implications of adaptation measures. California has begun to identify and implement adaptation measures that may substantially affect energy

generation and demand. For example, water agencies are investigating the use of natural groundwater reservoirs to store water during wet years and to lessen the effects of expected snowpack decline in the Sierra Nevada mountains. The energy demand implications of pumping water from these groundwater reservoirs is unknown. Research to identify the energy consumption implications of different adaptation options under consideration now and in the future is also needed.

This initiative will also research the potential evolution of the energy system to identify how the energy system will need to change to drastically reduce GHG emissions while avoiding or minimizing environmental impacts.

This initiative will use a practical approach by delving into engineering design issues for concrete steps that could be taken by electricity system managers. The research focus is on practical engineering applications that produce actionable products, but will also look at economic issues, including econometric and economic experiments, as needed to fully evaluate mitigation and adaptation opportunities. For example, Pacific Institute research has shown that with sea-level rise some coastal power plants will be in danger of coastal flooding. What is needed now are engineering studies to identify when the problem would materialize, what specific actions should be taken at these power plants, and what alternatives are available. The same can be said about effects of climate change on high-elevation hydropower units. Researchers have developed models that can adequately identify overall system impacts but are unable to generate practical local information that can be used to implement actionable adaptation measures at specific hydropower units.

Background: California leads the nation on climate change research. While there are national research efforts by different federal agencies, including the U.S. DOE and the National Academy of Sciences, they will not specifically address California and the unique challenges that climate change will present to the state. Non-governmental organizations have also expressed strong support for the spirit of this initiative in comments submitted to the CPUC by The Nature Conservancy, the Natural Resources Defense Council, the Union of Concerned Scientists, the Sierra Club, the Environmental Defense Fund, and others during the deliberations that culminated with the creation of EPIC.

Smart Grid Enabling Clean Energy

S6 Strategic Objective: Develop Smart Grid Technologies, Tools, and Strategies to Integrate Intermittent Renewables and Other Emerging Technologies.

Table 7: Ratepayer Benefits Summary Table for Strategic Objective 6

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S6.1 Enhance Distribution Automation to Integrate Distributed Energy Resources and Improve Grid Reliability.	X	X	X			X		X	X
S6.2 Monitor Customer Premise Networks and Microgrid Activity to Share Resources Across the Grid.	X	X	X					X	X
S6.3 Develop Technologies to Enable Power Flow Control and Bi-Directional Power Flow Through the Transmission and Distribution System.	X		X					X	X
S6.4 Develop Automation and Operational Practices Including Those for Outage Management, Congestion Mitigation, and Infrastructure Protection to Make Use of Smart Grid Equipment.	X		X	X				X	X
S6.5 Integrate Forecast Data of Renewables Into Automated Grid Operation.	X		X					X	X
S6.6 Enable Energy-Smart Communities to Facilitate Renewable Integration and Resource Aggregation.	X	X	X	X			X	X	X

Today's electric grid was designed for centralized generation. However, California is moving toward achieving the Governor's goal of 12 gigawatts of distributed generation. Variable

renewable resources, energy storage, microgrids, and customer-side-of-the-meter programs increase uncertainty in both supply and demand of electric power.

Electric grid operators must know how to efficiently and reliably operate a flexible smart grid with 33 percent renewable generation by 2020. Smart grid technologies can help with managing distributed generation (DG). Sensors, smart meters, demand response, and enhanced communications can provide more information about the power system and refine grid control. Automated smart grid operation, including the ability to aggregate and control loads and DG, will improve overall system efficiency and grid reliability. California ratepayers will see the benefits through reduced electricity costs and increased reliability.

The California legislature recognized the need for a smart grid and in 2009 passed the first statewide Smart Grid bill in the country. Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009) directed the CPUC to set requirements for investor-owned utility (IOU) smart grid deployment plans. All three of California's largest IOUs submitted their plans by July 2011. These plans included improvements in grid communications, automation of transmission and distribution (T&D) systems, standards and protocols, and other related areas to facilitate renewable integration to the grid. The *2007 Integrated Energy Policy Report* also identified the need for research in distribution control and automation to gain greater visibility of bi-directional power flow associated with distributed generation. This objective will address this need and other barriers to effectively managing a 21st century smart grid.

Transmission and Distribution Upgrades for Smart Grid

To meet the Governor's goal of 20 gigawatts of renewable generation by 2020, the existing T&D system must be upgraded to handle high penetrations of distributed and renewable energy resources, increase grid reliability, and shorten the downtime when outages do occur. The existing T&D system lacks the infrastructure and technical sophistication to support this goal while maintaining high grid reliability. With limited capacity for two-way power flows and without control and communication at the point of use, California's existing distribution system is not equipped to fully realize the benefits of distributed generation. Upgrades will include modernizing T&D equipment, enhancing automated distribution systems, and improving control over distributed energy resources.

Smart Grid Communications Systems

Utilities can improve electric service if they have a better understanding of the generators and loads behind the meter. This task becomes more difficult and complicated as more distributed generation and electric vehicles are added because the net power from local generation and loads are combined together within a distribution circuit.

Incorporating local generator and load data from Customer Premise Networks (CPN) into smart grid communications systems will help operators address potential problem areas in the distribution system and respond with the appropriate operational modifications, helping to

relieve grid congestion. Smart grid communications systems that are properly integrated with communications on the customer side of the meter will allow California electric ratepayers secure access to more information and options for electric services to lower their electricity costs.

S6.1 Proposed Funding Initiative: Enhance Distribution Automation to Integrate Distributed Energy Resources and Improve Grid Reliability.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X						X	

Issue: Existing distribution monitoring and control systems are not designed to manage high penetrations of distributed and renewable energy resources and cannot be used to control energy smart communities and microgrids. Besides data resolution and communication issues, more information on the behavior of variable renewable resources is needed for monitoring and control systems. Renewable energy exhibits non-typical generator behavior that makes it difficult for grid operators to manage. At the same time, the increasing load of plug-in electric vehicles introduces more uncertainty for electric supply and demand.

Purpose: This initiative will enhance distribution automation to integrate distributed energy resources (DERs) and improve grid reliability. This research will develop new emerging technologies to increase the amount of renewables that can be connected at the distribution level and provide greater control over the operation of DERs. Research will include methods to aggregate and control loads and DG, including plug-in electric vehicles (PEVs), to improve grid reliability. Grid operators will have a greater level of confidence in providing reliable electric service with high penetrations of renewable and distributed generation.

Examples of proposed research topics include:

- Developing synchrophasors for use in distribution systems.
- Developing technologies and strategies for T&D systems to handle renewable generation issues such as intermittency and voltage regulation.
- Investigating other functions of distributed generation and distributed storage, individually or in combinations.
- Developing controls capable of controlling all of the functions within energy smart communities and microgrids.

- Coordinating DG control between operators and energy aggregators.
- Determining the optimal aggregation of various types of DG, including PEVs.

Background: Utilities already have distribution management systems, but they lack the capability to respond fast enough to changes resulting from variable renewable generation at multiple connection points, including dispatching energy storage. Past research on synchrophasors on the transmission system successfully provided higher resolution data to the California ISO; therefore, the question for research is whether synchrophasor technology can be used to obtain detailed information about the distribution system. Other related barriers to enhancing distribution automation include managing large volumes of data and a lack of analysis tools to implement automated system changes.

One of the barriers to having a flexible grid is the inability to control distributed energy resources and loads at the grid level. Multiple stakeholders must be involved in coordinating DG control to maximize grid capacity and flexibility. There has been limited research in this generator and load aggregation because of market barriers. However, schemes using intelligent software agents to aggregate load and generation and wide-area management systems have undergone testing. Since 1996, various schemes for combining loads and electric vehicles have been proposed; however, none were implemented due to market barriers.

S6.2 Proposed Funding Initiative: Monitor Customer Premise Networks and Microgrid Activity to Share Resources Across the Grid.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X		X	X

Issue: The California ISO does not have information on the availability of customer-owned, DERs to be able to use any unused energy capacity on the grid. To integrate CPN and microgrid resources at the grid level, demand-side programs must also be well coordinated and monitored to fully use energy available through demand response and energy efficiency. CPN and microgrid data must be filtered to analyze only the relevant information for grid operations.

Purpose: This initiative will provide more visibility of CPN and microgrid operations, including DER availability, through the distribution system for grid support. This information will also feed into grid simulations of power anomalies (faults, oscillations, surges, and so on) originating at the customer level that may lead to overloads, faults, or instability on the T&D

system. The California ISO also wants to improve its metering and telemetry requirements to encourage a variety of providers, including aggregators, to participate in its markets, particularly to support renewable generation. Examples of proposed research areas include:

- Reduce metering and telemetry costs of participants in California ISO markets.
- Filter CPN and microgrid data and identify pertinent information for grid operators.
- Design control system to monitor and control DERs including energy storage.
- Disaggregate DG from loads.

Background: Data is already being collected under demand response programs for participating industrial and commercial customers that may be useful at the T&D level. Existing CPNs and microgrids may already have the necessary information for grid operators.

Various technologies and smart devices/appliances can provide electricity usage data; however, research is needed to determine a secure and reliable interface between customer-side-of-meter systems, such as CPNs and local energy storage, and the distribution system that is compatible with utility systems for more efficient power delivery based on customer demand.

S6.3 Proposed Funding Initiative: Develop Technologies to Enable Power Flow Control and Bi-Directional Power Flow Through the Transmission and Distribution System.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X	X	X	

Issue: Existing T&D equipment cannot handle the two-way power flow that occurs with DG connected at all levels in the electric system, from utility-scale storage down to a residential solar roof. The traditional design of the protection and control systems also prevents integrating high penetrations of DERs at various connection points throughout the system. Recently developed and deployed smart grid-enabled devices need to be coordinated into a single system that can easily assimilate new smart devices over time.

Purpose: This initiative will advance the development and deployment of new technologies to modernize the electrical transmission and distribution system for an adaptable and controllable smart grid. Examples of proposed research topics include:

- Developing synchrophasor technology for the distribution system.

- Developing new products such as flexible, alternating current transmission system devices and other direct control power flow devices.
- Developing technologies to increase T&D circuit capacities.
- Developing new or improving existing equipment to react quickly enough to adapt to variable behavior of renewable generators and loads.

Background: Past research on synchrophasors developed phasor measurement units to measure and transmit data about the transmission system to the California ISO. Early stage research on four-quadrant smart inverters, fault current controllers, and smart transformers is of interest to utilities. Existing distribution equipment such as switches, protective relays, capacitor banks, and voltage regulators cannot handle two-way power flow and will need to operate more frequently as more variable renewable generation, distributed energy storage, and electric vehicles are added to the grid. Inadequate T&D equipment is a critical barrier to renewable integration that must be overcome.

S6.4 Proposed Funding Initiative: Develop Automation and Operational Practices Including Those for Outage Management, Congestion Mitigation, and Infrastructure Protection to Make Use of Smart Grid Equipment.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X	X	X	

Issue: Grid operators lack the proper procedures for handling high penetrations of renewable resources because they do not know what to expect. The variety of characteristics of different types of renewable energy resources increases the complexity of operating the grid, especially as additional resources are connected. It is critical to have a comprehensive understanding of the changes in grid operations needed as penetration of renewable generation increases over time.

Purpose: This initiative will develop automation and operational practices including those for outage management, low system inertia, congestion mitigation, and infrastructure protection to make use of smart grid equipment. Examples of proposed research topics include:

- Determining effects on transmission systems from operational changes in the distribution system associated with distributed energy resource integration.

- Enabling dynamic thermal ratings for transmission lines to increase load-carrying capacity.
- Establishing thresholds for system inertia and frequency response and methods for maintaining those thresholds.
- Investigating methods for sharing multiple resources, such as energy storage, between balancing authorities (California ISO and Bonneville Power Authority).

Background: Past research has attempted to characterize grid reliability issues such as instability and renewable intermittency, and further research is needed to understand their impacts on the grid. However, there appears to be less research on how to modify grid operations to handle these issues. The traditional approach is to build more infrastructure such as new generators, circuits, and wires, but this approach is no longer sufficient for an observable, controllable, and adaptable grid with high penetrations of renewables.

Energy Commission staff held Technical Advisory Committee (TAC) meetings with the IOUs and the California ISO over the past several years to discuss T&D research needs. The TAC members have identified this research gap which needs to be addressed to integrate high penetrations of renewable and DG on the grid. Another barrier to renewable integration is transmission congestion. Research on understanding which transmission lines would most benefit from dynamic thermal line ratings could help increase transmission capacity for renewable generation and under extreme conditions.

The California ISO identified a specific research barrier regarding real-time monitoring. Grid operators want to incorporate frequency response and inertia limits into their generation commitment and dispatch procedures, but they do not know what these limits are for maintaining grid reliability.

S6.5 Proposed Funding Initiative: Integrate Forecast Data of Renewables into Automated Grid Operation.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X			

Issue: Weather events can dramatically affect the power output of renewable wind and solar generation. The resulting fast ramping strains the grid infrastructure, and the ability of grid

operators to reliably anticipate and react appropriately or automatically to these events does not yet exist.

Existing demand forecasting methods have been successful but force operators to make many assumptions. Automated monitoring of the electrical system and increased use of smart metering has made it easier to collect large amounts of system data. The merging of internal utility data and all publicly available data can help utilities better understand the operations of the electric system and better meet customer needs. Developing ways to integrate forecast data, including weather events and demand forecasts, into automated operation systems is necessary to streamline grid operations. There is a need to define data applications, assemble the analytics, and produce data visualizations and operation protocols for utilities.

Purpose: This initiative will develop the best practices and applications in data analytics and select specific examples to demonstrate with the utilities and the California ISO. These best practices could be in better outage management, DER management, renewable integration, or customer load management.

Background: Utilities have been collecting monitoring data in databases for many years. Other large databases exist in the public domain (for example, weather, traffic, and earthquakes). Much of this data is not used because it cannot be easily merged. Recently, industry has ramped up efforts to use this data. These activities are known as "data analytics" and apply to a wide variety of industries. A certain subset of the available data would be relevant to utilities for the purposes of weather forecasting and demand forecasting. There are also several vendors making available products that can perform data analytics without significant custom programming.

Data analytics in the context of grid operation and demand forecasting is new and not suited to full-scale demonstrations in the near term. The R&D activities the EPIC program would perform under this initiative will allow all California utilities to leverage the best practices and applications to be developed. The long period for the deployment of these best practices and applications fits with the EPIC program's time frame and mandate.

S6.6 Proposed Funding Initiative: Enable Energy-Smart Communities to Facilitate Renewable Integration and Resource Aggregation.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X						X	X

Issue: Utilities are concerned about protecting the distribution system particularly when dealing with increasing amounts of two-way power flow from DERs and large varying loads. Microgrids and other off-the-grid sources may create a sudden overload on the distribution system if these sources malfunction because of equipment failure, local faults, or a temporary shortage of resources such that they cannot meet their demand and need power from the grid. Utilities need enough real-time information about customer electricity usage to address these issues. However, access to CPN data must be strictly monitored and managed to maintain customer privacy and information integrity.

Purpose: This initiative will enable energy-smart communities by providing CPN data to the smart grid communication system, especially DER data. This information will give utilities a better understanding of actions "behind-the-meter" such as DG profiles and varying loads that may affect distribution operations. Monitoring the appropriate information from distribution-level renewable resources and loads will allow proper integration into the smart grid. Improving the smart grid communications system will also encourage aggregators to participate in California ISO markets. Examples of proposed research topics include:

- Developing and demonstrating communication standards for CPNs interfacing with the distribution system.
- Determining what distribution operations to modify and how to modify them based on information received from CPNs.
- Detecting low-level faults.

Background: Research in demand response programs using OpenADR protocol are now commercialized which included interfacing with CPNs for industrial and commercial customers. This research by Lawrence Berkeley National Laboratory may be applicable for other programs to encourage participation in California ISO markets.

Past research on microgrids provides information on community-scale, local generation and communications. The microgrid at the University of California, San Diego is an example of a multi-building system with local generation, energy storage, electric vehicle charging, combined heat and power, and various renewable technologies all integrated through one master controller.

S7 Strategic Objective: Develop Operational Tools, Models, And Simulations for Improved Planning of Grid Resources.

Table 8: Ratepayer Benefits Summary Table for Strategic Objective 7

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S7.1 Characterize the Generation Fleet of 2020 for Grid Operators and Planners.	x	x			x		x	x	x
S7.2 Improve Operator Dispatch and Visibility of Distributed Energy Resources.	x	x			x			x	x
S7.3 Develop and Run Real-Time Scenarios to Support Operations, Including Energy Storage Utilization.	x	x			x	x	x	x	x
S7.4 Develop Interoperability Test Tools and Procedures to Validate New Subsystem Integration into the Grid.	x	x	x	x	x		x	x	x

To enable increasing penetrations of intermittent renewable energy into California's grid while maintaining reliability, a number of grid-operation tools, planning enhancements, and simulation tools need to be developed and implemented. Better models and tools are needed to evaluate the resource needs and operating characteristics of potential future energy fleets, and incorporate them into future planning processes. Most future scenarios will likely include increasing amounts of distributed energy resources, including variable renewables. Increasing the visibility and dispatchability of these distributed resources will enable grid operators to more accurately predict resource availability and more efficiently operate the grid. Development and evaluation of real-time scenarios can further support efficient grid operations. Finally, it is essential to understand the operating characteristics of emerging energy resources before they can be integrated into the grid and incorporated into grid planning.

In light of California's stated clean energy goals, the composition of the 2020 grid will likely look somewhat different than it does today. To understand what tools, technologies, and

resources will be needed to ensure grid reliability, it will be essential to characterize California's potential energy fleet for a number of future development scenarios. Better characterization of grid resources will enhance system visibility and allow for better modeling of the electricity generation fleet to create greater operational stability and robustness. This characterization will increase reliability and lower the costs of operation for utilities and ratepayers in California.

Providing grid operators with the ability to run real-time scenarios to support grid operations, including energy storage use, will allow grid operators to more effectively use the capabilities of smart grid equipment in everyday operation and thus improve the return on investments in smart grid infrastructure. Allowing operators to more effectively anticipate and react to disruptive events will also improve the resilience and reliability of smart grid operation. These advantages provide economic benefits to utility ratepayers by decreasing the costs resulting from fewer emergency response costs.

Developing interoperability test tools, models, and procedures to validate new subsystems into the grid will ensure the security, safety, and interoperability of grid equipment. This will result in fewer disruptive events and safety hazards, improving public confidence in and the cost-effectiveness of grid operations. Minimizing the deployment of proprietary, non-compatible subsystems will allow more companies to develop innovative grid infrastructure. A safe, interoperable, and secure infrastructure accelerates the adoption of renewable electrical generation.

S7.1 Proposed Funding Initiative: Characterize the Generation Fleet of 2020 for Grid Operators and Planners.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X	X		

Issue: With the increasing adoption of variable and intermittent renewable generation, the operating characteristics of the grid have changed fundamentally. The current fleet of generation equipment is a combination of legacy units and new additions with greatly varying characteristics of output capacity, fixed and variable costs of operation, geographical locations, load following capability, and controllability. There would be value in characterizing an optimal path for additions and alterations to the generating equipment fleet in California. Until a generation fleet is characterized and modeled, taking into account interconnection to the T&D system, the load following capability, controllability, and other factors of the generation units,

California ISO and the utilities are lacking a tool for determining the most cost-effective evolutions of California's generation fleet.

Purpose: This initiative calls for research into characterizing a generation fleet from the perspective of cost-effectiveness and robustness. There is a need for a baseline and an "ideal" objective for the optimal evolution of the generation fleet. Having detailed models of present and possible future generation configurations will allow better evaluation of additions, modifications, and decommissioning activities to occur as the generation fleet evolves.

Background: Models currently provide information on different facets of grid operation and economics. They vary in the timescales, subsystems, and variables under investigation. Current models for renewables are simplistic and based on limited knowledge of the resources. These models must be augmented for a wider variety of applications and validated for use in generation fleet planning. They should take into account the impacts of current and projected fuel costs, plant commissioning and decommissioning activities, increasing renewable penetration, and energy storage including plug-in electric vehicles.

Allowing the build-out, modification, and decommissioning of generation units to proceed from a cost and operational standpoint will result in lower costs for utilities and ratepayers. New modeling capabilities will inform decisions for changes in the generation fleet, thereby supporting stable grid operation and robustness to benefit California's economy.

The Energy Commission is geared to administer research projects under this initiative because this initiative's objectives fit with the mandate and time frame of the EPIC program. Generation fleet characterization is a California-wide activity covering multiple utility service territories, and it will be cost-beneficial and equitable for a non-utility entity to perform the fleet characterization activities.

S7.2 Proposed Funding Initiative: Improve Operator Dispatch and Visibility of Distributed Energy Resources.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X		X	X

Issue: Many distributed energy generation resources are aggregated with loads on the customer side of the meter. This presents a problem for grid operators because the DG is often solar PV or wind that ramps up and down dramatically within seconds or minutes in response to weather events. The inability of operators to see proportions of load and generation on the distribution

level greatly limits their flexibility and situational awareness. Operators need higher granularity of the distributed energy resources to maintain service reliability.

Purpose: This initiative calls for the cataloguing characteristics of distributed energy resources in California to allow utilities and the California ISO to operate with far more visibility. This requires cataloguing the location, size, and type of distributed generation equipment and developing new tools using the database. The increased visibility of DG will improve operating characteristics and provide greater confidence in advanced planning for weather and demand events.

Background: Probabilistic and historical decision support tools are used to plan generation dispatching, but these same tools could be used to greater effect if grid visibility is improved by cataloguing distributed energy resources and disaggregating generation from load. The need to disaggregate generation from load is critical at this time as the penetration of fast-ramping DG such as solar PV is expanding. The uncertainty surrounding the minute-to-minute output of these generation sources would be reduced if those generation sources were accurately catalogued and matched to regional current and forecast weather patterns.

Utilities will proceed with deploying their own grid modeling and operational tools in the future. These tools will be more effective once the utilities are furnished with data that accurately maps the locations and types of distributed energy resources. Developing the methods to gather and compile this data is itself an activity that requires effort; therefore, it would be duplicative if each utility mapped the distributed generation in its own territory. It is more efficient and equitable for a statewide entity such as the Energy Commission to perform the generation mapping activities which the utilities will then leverage for grid operations.

S7.3 Proposed Funding Initiative: Develop and Run Real-Time Scenarios to Support Operations, Including Energy Storage Utilization.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X			

Issue: Utilities have limited visibility and control of grid system resources, including energy storage of various types, as well as distributed renewable generation. The inability of utilities to see and model various smart grid resources in real-time, as well as the proportions of load and generation on the distribution level, greatly limits flexibility and situational awareness and degrades the robustness of the electric grid.

Purpose: This initiative will develop models and tools with real-time and automation capability to improve smart grid operations. These tools will provide grid operators with real-time assessments of the condition of the grid and a greater amount of control of T&D level resources. A possible research project under this initiative is to determine the "point of diminishing returns" for the granularity of grid visibility and control to ensure cost effectiveness.

Background: Recent improvements in supervisory control and data acquisition, advanced metering infrastructure, geographic information systems, and computation can improve existing distribution models. This ability can tie together many data inputs in grid operation and enable distribution simulation and analytics. These models could very quickly run scenarios to show the effects of system planning or forecast weather to aid in real-time operation. The models can also be useful for future renewable and electric vehicle integration studies.

Significant effort will be expended in developing these models and tools, which California utilities will later use in planning and real-time operations. If each utility were to develop its own models and tools, there would be significant duplication of effort, and it would be inequitable if one utility were to develop models and tools that would then be applicable throughout California. Therefore the Energy Commission, with continuous stakeholder input, is equipped to administer research activities to create and improve models and tools for grid operations, including energy storage use.

S7.4 Proposed Funding Initiative: Develop Interoperability Test Tools and Procedures to Validate New Subsystem Integration into the Grid.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X		X	X

Issue: New smart grid hardware is being developed and deployed for customer-side applications and for the distribution and transmission levels. Smart grid hardware provides the foundational capabilities for integrating large amounts of variable renewable generation by making resources such as energy storage and demand-side programs available. However, the smart grid paradigm makes the electric grid significantly more complex and increases the number and variety of potential failures. It is critical to ensure that every smart grid subsystem is safe, interoperable, forward compatible and, when applicable, equipped with cost-effective security. These measures will reduce disruptive events in the complex grid system, improve safety, and increase customer confidence in the smart grid infrastructure.

Purpose: This initiative will develop test tools, simulation models, and procedures to validate the safety, interoperability, and security features of new grid–connected equipment. These tools will validate the wide array of emerging customer-side equipment, including energy storage and vehicle-to-grid interconnection technologies, as well as distribution and transmission level infrastructure.

Background: Standards for certain grid subsystems have been developed, but new capabilities and operating paradigms are appearing that do not fit neatly into existing standards and certifications. Without a more coherent and comprehensive set of interoperability standards and test procedures, some new smart grid equipment will not be capable of operating in certain contexts or systems. This would adversely affect customers' adoption of smart grid equipment due to the impaired economics stemming from restricted equipment choices and capabilities. With greater equipment interoperability, customers would have greater access to a larger number of smart grid subsystems applicable to their needs.

Currently, utilities leverage nationally adopted standards and protocols for the delivery of information to authorized third parties and for the transmission of information among customer and third party devices and utility smart devices. All procedures and practices must meet local, state, and federal requirements, and to reduce duplication of effort it is efficient for a statewide entity such as the Energy Commission to develop the interoperability test tools and procedures. To provide vendors and utilities with tools and procedures that are easy to use and most applicable to their needs, stakeholder input will be a continuous and integral part of activities in this initiative.

S8 Strategic Objective: Integrate Grid-Level Energy Storage Technologies and Determine Best Use Applications to Provide Locational Benefits

Table 9: Ratepayer Benefits Summary Table for Strategic Objective 8

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S8.1 Develop Innovative Plant-Level Energy Storage Technologies and Applications to Mitigate Intermittent Utility-Scale Renewable Energy Generation and Meet Peak Demand.	X		X			X	X	X	X
S8.2 Optimize Energy Storage Deployment with Respect to Location, Size, and Type.	X	X		X	X	X	X	X	X

This objective supports the goals of AB 32 and the Renewables Portfolio Standard. Grid-level energy storage enables the broader adoption of variable and intermittent renewable energy, reducing greenhouse gas emissions and environmental costs. Grid-level energy storage allows the electric grid to function more optimally and cost-effectively.

This objective will provide ratepayer benefits by enabling increased penetrations of renewable energy at the utility scale while maintaining grid reliability. Energy storage can offset the need for expensive natural gas plants to provide reserve capacity and load-following ability. Research activities will enable further de-carbonization of California's electricity generation portfolio.

Optimizing energy storage deployment with respect to location, size, and type allows the electric grid to function more optimally and cost-effectively. This will benefit utility ratepayers and improve the flexibility and economics of integrating variable and intermittent renewable integration.

S8.1 Proposed Funding Initiative: Develop Innovative Plant-Level Energy Storage Technologies and Applications to Mitigate Intermittent Utility-Scale Renewable Energy Generation and Meet Peak Demand.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	

Issue: The reliability of California's energy system depends on the ability to meet peak power demand. The electric utilities on hot summer afternoons use many "peaker" natural gas plants that run for just a few hours a year. To satisfy peak demand, very high prices are paid on the spot market to these plants that pollute more and are less efficient than other power plants. Renewable power, such as solar and wind, is often intermittent and is available a limited number of hours every day. As a result, renewable energy can be difficult to integrate into the base load of the overall energy delivery system. At present, most long-term storage applications, such as Lithium-ion batteries, are far too costly and are not a substitute for transmission upgrades. Higher capacity storage technologies such as pumped hydro and compressed air energy storage have special site requirements.

Purpose: The Energy Commission will fund applied research and development activities to develop innovative plant-level energy storage technologies and applications to mitigate

intermittent utility-scale renewable energy generation and increase the value of energy generated to grid operators. Potential applied R&D activities include the development of advanced thermal energy storage systems that can be coupled with utility-scale concentrating solar plants to alleviate short-term intermittency effects and provide additional ancillary services to the grid, including regulation services and reserve capacity.

Electric energy storage, such as batteries of various chemistries, will be evaluated and developed for their ability to be coupled with utility-scale wind and solar power plants to smooth short term ramping events and allow electricity generated by these installations to be stored and dispatched when it is needed most, at times of peak demand. Other forms of mechanical energy storage, such as pumped hydro installations and compressed air energy storage (CAES), should be evaluated for their potential applications at utility-scale renewable energy plants, and ultimately deployed wherever found to be cost effective. Additional research may focus on required changes to existing energy storage systems to help balance generation and load second-by-second, minute-by-minute, and over the long term.

Background: The California Independent System Operator (California ISO) has identified energy storage as an important tool to enable integration of renewable energy at increasing penetration levels, along with demand response and flexible natural-gas fired power plants. Energy storage and fast-ramping power plants allow electricity supply to more smoothly match the increasingly unpredictable minute-to-minute electricity demand. The California ISO will require advanced renewable resource prediction models and operational tools to incorporate into its planning processes.

Utilities recognize certain energy storage technologies as immature technologies. Utility investment policies mandate that the benefits of projects must exceed costs, a condition that will be satisfied more often once plant-level energy storage technologies are developed further by statewide research activities under the EPIC program.

Furthermore, Governor Brown's Clean Energy Jobs Plan encourages the development of energy storage systems, which could lead to 8,500 permanent new jobs if the utilities procure storage equivalent of 5 percent of their peak load demand.

S8.2 Proposed Funding Initiative: Optimize Energy Storage Deployment with Respect to Location, Size, and Type.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X		X	

Issue: As energy storage technologies are adopted, their specific features such as discharge duration, inertia, location, and availability more deeply affect grid operation and flexibility. For instance, a large cluster of grid-level energy storage located at the wrong side of a choke point in the transmission infrastructure will not be able to benefit the grid to the extent it might have if it had been sited more thoughtfully. Metrics and decision-support tools should be developed to optimize the placement and types of energy storage.

Additionally, utilities and other planners do not and will not have significant control over the placement of distributed small-scale energy storage resources such as plug-in electric vehicles (PEVs).

Purpose: Developing methods and tools to strategically optimize grid-level energy storage with respect to location, size, and type will allow the electric grid to function more cost-effectively and with greater reliability. Research under this initiative will consider many factors including the consequences of the lack of control over the deployment of some small-scale distributed energy storage such as PEVs.

Background: Various energy storage technologies are being developed and refined. Two examples are presented here. Flywheels are evolving from exclusively power devices, which have the capability to discharge over a period of minutes, into load-shifting devices that have higher energy capacities and can discharge over a period of hours. This increases their usefulness and range of functions for grid energy storage. Ultracapacitors have fallen dramatically in price over the past decade, and this makes them newly cost-effective as high-power storage for renewable output stabilization. These new developments and capabilities change the nature of grid-level energy storage and call for refinements in the ways they are planned and deployed.

Utilities recognize certain types of energy storage technologies as immature technologies, and their investment policies mandate that the benefits of projects must exceed costs. As research activities improve energy storage technologies, this condition that will be satisfied more often, and energy storage will expand and more deeply affect grid operation and flexibility. A statewide effort under the EPIC program to develop methods and tools to optimize grid-level storage deployment will be an efficient and equitable way to maximize the benefits of energy storage in California.

S9 Strategic Objective: Advance Plug-In Electric Vehicle Infrastructure and Use EVs to Improve the Operation and Performance of California's Power Grid.

Table 10: Ratepayer Benefits Summary Table for Strategic Objective 9

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S9.1 Reduce Both Plug-In Electric Vehicle Costs and Distributed Storage Costs Through the Development of Second-Use Battery Storage Applications.	X	X	X	X	X	X		X	X
S9.2 Develop And Evaluate Smart Charging Technologies and Approaches to Integrate Plug-In Electric Vehicles into the Power Grid.	X	X	X	X	X	X		X	X
S9.3 Develop Novel Technologies and Strategies to Increase the Energy Efficiency of the Electric Transportation System.	X	X	X	X	X			X	X
S9.4 Develop Advanced Recycling Technologies and Processes for Recycling Plug-In Electric Vehicle Batteries.			X	X					
S9.5 Develop Grid Communication Interfaces for Plug-In Electric Vehicle Charging to Support Vehicle-to-Grid Services.	X	X		X	X	X		X	X

Plug-in electric vehicles and other electric transportation technologies offer a promising and potentially revolutionary alternative for meeting the state's transportation needs. These vehicles offer a number of benefits over conventional vehicles including lower fueling costs, reduced air pollutants, and reduced greenhouse gas emissions. Furthermore, plug-in electric vehicles – when integrated with smart charging technologies and other strategies - can provide a number of benefits to grid. The Energy Commission is proposing to provide xx dollars for the following initiatives:

S9.1 Proposed Funding Initiative: Reduce Both Plug-In Electric Vehicle Costs and Distributed Storage Costs Through the Development of Second-Use Battery Storage Applications.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: The high cost of lithium-ion batteries is the primary barrier to the commercial success of plug-in electric vehicles. One potential strategy to reduce battery costs is to reuse the lithium-ion batteries – after they are no longer usable in the vehicle – in stationary energy storage devices. These devices might not only provide valuable services needed by existing statewide grid-support markets, but could provide customer-side-of-the-meter benefits, improve utility operation, help defer costly grid upgrades, and potentially support the profitability and penetration of intermittent renewable energy. The revenues generated from these "second-life" energy storage applications could potentially offset the high costs of the battery packs, lowering both the costs and risks to auto manufacturers and plug-in electric vehicle consumers. However, a number of issues – both technical and economic - need to be addressed before a viable market for second-life battery energy storage applications can develop.

Purpose: This initiative will continue to advance the development of second-use applications. This will include pilot-scale demonstrations of second-life storage applications in real-world conditions sufficient to verify their technical performance. In addition, this initiative will research and develop technologies and strategies to reduce the cost of repurposing EV batteries into second-life storage devices.

Background: In 2011, the Energy Commission funded the first ever study on second-life storage applications for lithium-ion vehicle batteries. Advanced simulation tools used in the study determined that the most suitable and profitable storage applications for used vehicle batteries are "area regulation" and "load following." Testing to determine if used vehicle batteries could meet real-world requirements for "area regulation" and "load following" was performed on various battery packs and modules from different battery manufacturers and found that the majority of vehicle batteries performed exceptionally well in the simulated conditions. The National Renewable Energy Laboratory provided an additional $660,000 to this effort to conduct long-term field testing of second-life applications at the UC San Diego campus. This long-term testing, which began in February 2012, will more fully advise key aspects of the potential second-life market for used plug-in electric vehicle battery packs.

S9.2 Proposed Funding Initiative: Develop And Evaluate Smart Charging Technologies and Approaches to Integrate Plug-In Electric Vehicles into the Power Grid.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Depending on how, when, and where they are charged, plug-in electric vehicles affect the electricity system in various ways. The anticipated rapid growth of plug-in electric vehicle (PEV) charging can potentially add significant load to the power grid and increase peak demand. Research also indicates that managed plug-in electric vehicle load, through appropriate tariff or other command and control mechanism, has the potential to increase off-peak demand. The increase in off-peak demand may flatten the electricity system load shape and improve utility transmission and distribution asset utilization while increasing utilities' load factor. A flattened load shape results in more efficient utilization of power plants and transmission and distribution assets, which lower average electricity costs.

Purpose: Traditionally, diverting higher peak loads to off peak has yielded the most positive means of stabilizing the power grid. One strategy to manage the high number of electric vehicles requiring charging is to deploy a smart charging method. The smart charging method allows utilities the ability to charge vehicles according to the needs of the power grid.

This initiative will allow utilities the ability to better manage peak load through communication and control of vehicle battery system. Through load shifting of demand from off to on peak, smart charging will allow utilities to improve stabilization of the power grid. This initiative will provide ratepayer benefits by reducing peak load, stabilizing the grid, and promoting greater reliability. Smart charging will also benefit PEV owners by providing the most economical option to vehicle charging.

Background: The UC Davis Plug-in Hybrid & Electric Vehicle Research Center is currently conducting research analyzing the usability a functionality of a charging interface that helps inform the electric vehicle user the tariffs associated with on peak charging. The results and findings from this work is pending completion of the project. There are currently ongoing efforts to test and analyze methods of leveraging smart grid communications technology to enable advanced Plug-In Electric Vehicles (PEV) charging Demand Response (DR) applications.

S9.3 Proposed Funding Initiative: Develop Novel Technologies and Strategies to Increase the Energy Efficiency of the Electric Transportation System.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X						X	X

Issue: Electricity demand in IOU territories is expected to increase as the transportation sector becomes more electrified to meet the state's environmental, public health, and energy security goals. "One utility impact scenario analysis projects up to an 11 percent total energy demand in 2020 within its service territory due to on-road and non-road electric vehicle load." On top of this, additional demand due to transportation electrification will raise the total renewable energy generation cost required to comply with the Renewables Portfolio Standard.

Purpose: This initiative will develop innovative new technologies and strategies to improve the energy efficiency of electric transportation in the following areas:

- Develop, test and evaluate vehicle-side efficiency technologies and strategies: This initiative will conduct research to advance next-generation HVAC systems to reduce heating and cooling demands on the vehicle battery pack; develop and test vehicle light weighting strategies; and test and validate novel strategies – such as eco-driving - that can improve the driving efficiency of plug-in electric vehicles. Improving the energy efficiency of electric transportation will reduce electricity demand on the grid and decrease fueling costs for plug-in electric vehicle consumers. Vehicle efficiency improvements can also reduce the upfront vehicle purchase cost since greater efficiency will allow auto manufacturers to reduce the battery pack storage capacity will still achieving the same vehicle range.
- Advance the development and deployment of more efficient charging infrastructure: Wireless charging technologies for plug-in electric vehicles off a number of benefits to consumers including improved convenience and safety. In addition, wireless charging can help address barriers to plug-in electric vehicle ownership for disable populations. However, wireless charging technologies are less efficient than their plug-in counterparts. State-of-the-art wireless technologies lose roughly 10 percent of their electricity during the charging process. This initiative will conduct research to advance the development and deployment of more efficient wireless charging technologies.

Background: In 2009, the Energy Commission co-funded a project with the National Energy Technology Laboratory to develop and demonstrate an advanced HVAC system – using

thermoelectric technology – to reduce vehicle heating and cooling energy requirements by 33 percent. The Energy Commission also provided funding for the California Hybrid, Efficient and Advanced Truck (CalHEAT) Research Center to demonstrate prototype vehicle light weighting strategies and plug-in electric vehicle applications for medium- and heavy-duty vehicles.

S9.4 Proposed Funding Initiative: Develop Advanced Recycling Technologies and Processes for Recycling Plug-In Electric Vehicle Batteries.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X						X	X

Issue: Despite the energy and emission benefits of plug-in electric vehicle use, the "cradle-to-grave" benefits are less certain due to battery production and disposal impacts. Recent studies estimate that battery production accounts for roughly 20 percent of a plug-in electric vehicle's carbon footprint and 20 percent of its sulfur oxide emissions. Battery disposal could also have significant land use impacts if batteries are sent to landfills instead of recycled; and although lithium is 100 percent recyclable, producing battery-grade lithium from current recycling processes is about five times more costly than production from virgin materials.

Purpose: This initiative will be further develop and evaluate advanced technologies and methods for the safe and efficient recycling of battery backs from plug-in electric vehicles. In addition, this initiative will develop the data and tools needed to inform the development of a recycling infrastructure for PEV batteries in California.

Background: A Frost and Sullivan report estimates that the market for recycling PEV batteries to be worth more than $2 billion by 2022, with more than half a million end-of-life EV battery packs available for recycling through the waste stream. Argonne National Laboratory and the U.S. Environmental Protection Agency have commissioned studies with battery manufacturers to examine the life-cycle impacts of automotive lithium-ion batteries. Argonne National Laboratory found that recycling lithium-ion battery materials potentially reduces the material production energy by 50 percent; and advanced recycling processes that recover battery-grade materials have the potential for even greater energy savings.

S9.5 Proposed Funding Initiative: Develop Grid Communication Interfaces for Plug-In Electric Vehicle Charging to Support Vehicle-to-Grid Services.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X		X	X

Issue: Electric vehicle charging and the effects on the grid are not well understood, including how plug-in electric vehicles (PEVs) can provide additional energy to the grid when not in use. These issues are particularly critical if the PEVs are concentrated in one regional area in the distribution system. There may be specific elements to the PEV charging profile that impact the distribution system which may be obtained by analyzing CPN data. Security issues regarding electricity pricing signals, data privacy, and system integrity may impede full adoption of this technology if it is not cost effective to reliably implement these elements.

Purpose: This initiative will develop grid communication interfaces for PEV charging to support vehicle-to-grid services. Monitoring electric vehicle charging will provide useful information on how to optimize grid connections wherever the vehicles are located and their effects on those particular distribution circuits. Information from CPNs can provide critical information on PEV charging characteristics and customer usage to avoid major problems in distribution system operations and support vehicle-to-grid connections. Examples of proposed research topics include:

- Developing and demonstrating communication standards for CPNs and PEV charging systems are compatible with grid communications.
- Sharing CPN data across utility service areas.
- Coordinating PEV electricity use in clusters and across multiple utility territories.
- Developing PEV infrastructure for remote control and data communications.
- Demonstrating new vehicle-to-grid technologies with utilities and the California ISO.

Background: San Diego Gas & Electric Company is designing and assembling a PEV simulator that can be used to conduct testing of typical distribution grid feeder arrangements. This testing will measure the actual effects of charging vehicle batteries and provide data that can be transferred to computational models. This project will also demonstrate PEV charging that integrates renewable generation, energy storage, and smart charging to show that grid performance, reliability, and power quality can be maintained even with the introduction of a substantial PEV charging load.

The U.S. Department of Defense also has a project to convert all non-tactical, base vehicles at the Los Angeles Air Force Base to PEVs. These medium- and heavy-duty PEVs will demonstrate vehicle-to-grid services by participating in the California ISO ancillary services market.

Major utility and customer stakeholders are interested in vehicle-to-grid services but do not know how this technology and the communications with the California ISO can be implemented in an efficient, cost-effective manner.

Cross-Cutting

S10 Strategic Objective: Leverage California's Regional Innovation Clusters to Accelerate the Deployment of Early-Stage Clean Energy Technologies and Companies.

Table 11: Ratepayer Benefits Summary Table for Strategic Objective 10

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S10.1 Provide Small Grants to Early-Stage Energy Companies and Entrepreneurs Through Regional Innovation Clusters.		X		X			X	X	X
S10.2 Support Demonstration Testing and Verification Centers to Accelerate the Deployment of Pre-Commercial Clean Energy Technologies.		X		X				X	X
S10.3 Provide Cost Share for Federal Awards.		X		X					

California's research institutions, small businesses, and entrepreneurs – along with the U.S. Department of Energy's National Labs – are teeming with new energy technologies that if commercialized could provide significant benefits to ratepayers. The state's regional innovation clusters may be ideally suited to connect these technologies to the market needs. EPIC provides an opportunity to develop new initiatives that do not reside in the prior programs.

S10.1 Proposed Funding Initiative: Provide Small Grants to Early-Stage Energy Companies and Entrepreneurs Through Regional Innovation Clusters.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	X

Issue: Emerging energy companies and entrepreneurs with bench-validated technologies must overcome a number of obstacles to turn innovations into successful businesses. These early-stage companies often have management teams heavily weighted with researchers possessing little business experience, which increases the private sector's perception of investment risk. Furthermore, technology innovation is often disconnected from the regional economic resources and private capital needed to develop sound business models.

Purpose: This initiative will work with regional innovation clusters to provide small grants to entrepreneurs that have developed and verified innovative clean energy products at the bench-scale, but do not have the expertise, resources, or market connection to create a commercialized offering. Grant funding will be awarded in tandem with capital from private investors to leverage public-private partnerships and increase the likelihood of promising clean energy innovations developing into competitive commercial products. Grants awarded through regional innovation clusters will:

- Reduce capital cost barriers for early-stage clean energy companies.
- Establish business connections based on mutual interests.
- Demonstrate a high-level of due diligence to alleviate any concerns private investors may have with the technology or innovation.
- Help promising innovations overcome the commercialization valley of death.

Funding amounts will be dependent on the nature of the innovation and the level of risk associated with developing the product. Grants will be awarded for targeted hardware and software innovations in all of the major EPIC funding categories, including:

- Energy efficiency and demand response technologies and measures.
- Clean energy generation systems and deployment strategies.
- Transmission and distribution hardware.
- Grid operations and systems management.

- Integration of transportation electrification.

Background: Regional cleantech groups provide a venue to strengthen local economies, while bringing promising clean energy products to the marketplace. A number of regional cleantech groups exist in California, each with differing models and priorities based on regional technological and economic priorities. Through EPIC, the Energy Commission plans to leverage the capacity of these regional cleantech innovation groups to accelerate the development and commercialization of promising energy innovations to strengthen California's clean energy economy.

S10.2 Proposed Funding Initiative: Support Demonstration Testing and Verification Centers to Accelerate the Deployment of Pre-Commercial Clean Energy Technologies.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X				X	X	X	X

Issue: Early-stage emerging energy technologies face numerous obstacles before products can be commercialized and business models can become profitable. Due to these issues, many promising clean energy ventures fail to reach full commercialization. Testing centers can increase the rate and level of commercial success for advanced clean energy technologies. By performing rigorous due diligence on the performance, safety and economics of energy components and systems, testing centers can help to address private investor concerns and remove barriers to the commercialization of innovative energy technologies.

Purpose: This initiative will provide funding for the development and operation of regional testing and verification centers in California. These centers will provide the facilities, permitting, and equipment to enable companies to test and verify their pilot-scale technologies in environments that approximate real-world conditions. These testing and verification centers will work with potential early-adopter end-users to develop specifications that meet the customers' needs. This initiative will develop clean energy generation testing centers to validate the environmental performance and cost-competitiveness of emerging clean energy generation components and technologies at the pilot-scale. These testing centers will leverage public-private partnerships to accelerate the commercialization of next-generation clean energy technologies, including:

- Biomass-to-energy systems.
- Combined heat and power systems.

- High-efficiency photovoltaic systems.
- Low-cost wind energy components.
- Advanced inverter technologies.
- Marine renewable energy technologies.
- Advanced hydrokinetic turbines.

Testing centers will provide a variety of functions to support the incubation of promising energy technologies and strengthen California's clean energy economy. Clean energy testing centers will provide a number of functions, including, but not limited to:

- Start-up assistance to demonstrate emerging energy technologies at the pilot scale
- Access to pre-permitted demonstration facilities and equipment for environmental compliance testing.
- On-site technology installation and engineering support.
- Business consultation services to evaluate business cases for technology types.
- Recommendations for potential technology integration opportunities.
- Evaluations of additional applied research activities to reduce technology costs, improve performance, or achieve economic feasibility at various scales.
- Advising technology codes, standards, and safety certifications.
- Working with local universities to train engineers, collaborate with academia, and advance renewable energy education.

Background: The 2007 National Defense Authorization Act required that the U.S. Department of Defense (U.S. DOD) produce or procure 25 percent of all energy from renewable sources by 2025.[38] To support this effort, U.S. DOD has funded the operation of multiple energy technology testing centers across the United States. One such testing center, the Technikon Renewable Energy Testing Center at McClellan Air Force Base in California, provides third-party analysis of promising waste-to-energy technologies. Similar testing centers could be developed for a number of other clean energy technologies.

38 United States Code, Title 10, Section 2911, as amended by Section 2852 of Public Law 109–364, 109th Congress, ,http://www.gpo.gov/fdsys/pkg/PLAW-109publ364/pdf/PLAW-109publ364.pdf.

S10.3 Proposed Funding Initiative: Provide Cost Share for Federal Awards.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	X

Issue: There may be opportunities for the Energy Commission to use EPIC funds as cost share to leverage future federal investments that provide significant benefits to the state's IOU ratepayers. Because these future cost share opportunities are released through other federal agencies (for example, U.S. DOE, DOD, Department of Labor [DOL]), the timing and scope of the proposed cost share opportunity cannot be pre-defined or pre- approved in the investment plan. Without a set aside for federal cost share, the Energy Commission may not be able to use EPIC funds as effectively to attract significant federal investments to California.

Purpose: This initiative will provide EPIC funds as cost share to leverage Federal investments for projects that (a) meet the guiding principles of the Decision; and (b) cannot use funding from other proposed initiatives in the investment plan as cost share due to timing or scope constraints. Examples of federal cost share opportunities include:

- Co-funding projects in IOU territories with federal agencies including the U.S. Department of Energy, Department of Defense and others as appropriate.
- Providing cost-share funding for California entities that receive funding from the U.S. Department of Energy, the Department of Defense, and others as appropriate.
- Continuing to provide match funding for the multistate West Coast Regional Carbon Sequestration Partnership (WESTCARB) program that is funded by the Department of Energy and been managed by the California Energy Commission since 2003.

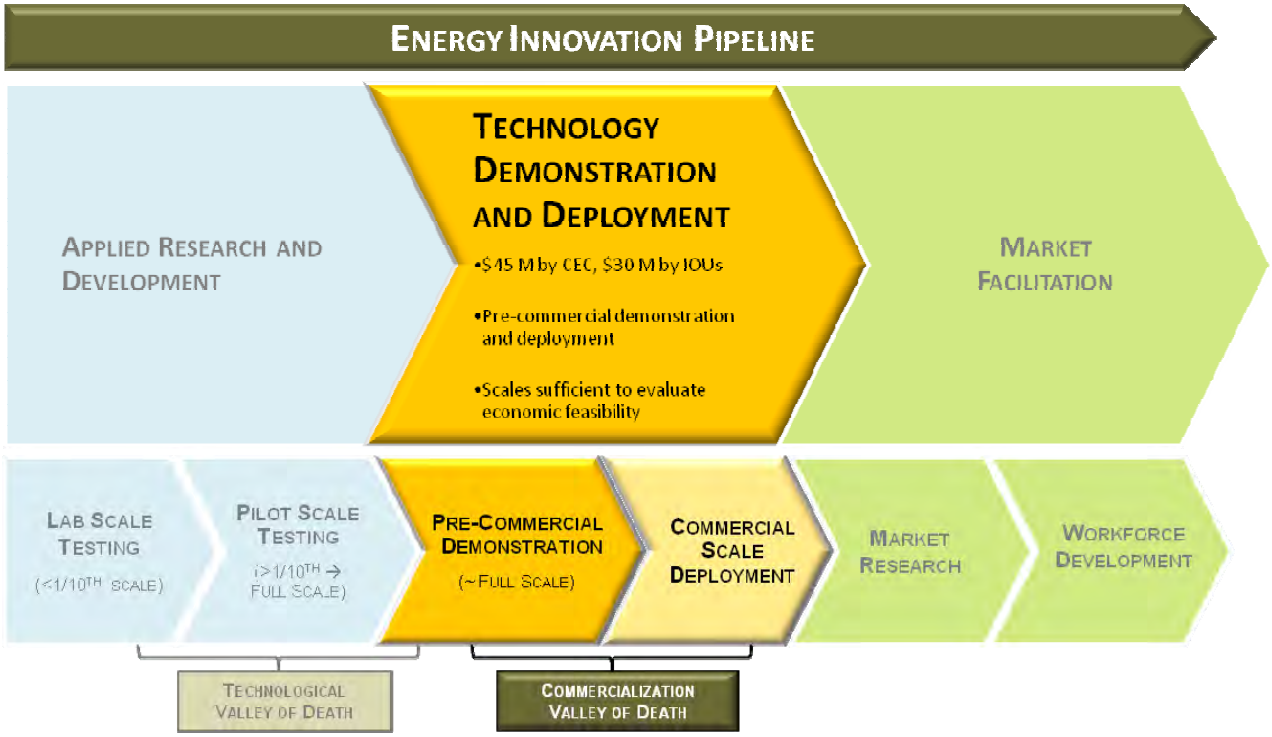
Background: Over the past few years, the Energy Commission has been able to leverage significant federal funding to California. For example, the Energy Commission provided cost share to California entities that received American Recovery and Reinvestment Act (ARRA) awards. As a result of this cost share, California was able to leverage more than $500 million in ARRA funds with a contribution of only around $20 million of state funds. Without this state cost share, many of the projects would not have been selected by the U.S. DOE for funding and California would have lost the benefits of the tax revenues, jobs, and California-based manufacturing capabilities that these ARRA projects provided.

In another example, the Energy Commission is the overall project leader for the multistate WESTCARB program that is funded by the Department of Energy. In addition to directly supporting California's emission reduction policies, the WESTCARB grant has leveraged substantial federal and industrial cost-share funding directly into the California economy. To date, the WESTCARB research effort includes more than $20 million in federal funds and more than $5 million in industry match funds — all leveraged at a cost of less than $6 million in California's research funds. Although six other states also participate in the WESTCARB partnership, more than 75 percent of the federal funds and industrial funds have been utilized in California to generate jobs and create future opportunities for California businesses.

The Commission envisions continuing this partnership in the future and requesting additional U.S. DOE funds. For the three-year period, it is expected that the WESTCARB grant will require $3 million to $6 million in EPIC funds to match $10 million to $30 million in federal U.S. DOE and industry cost share funding. The funding will be used to help California utilities meet future emission reduction goals. One area of specific interest is the demonstration of CO2 capture, transmission, utilization and storage from an IOU operated natural gas combined cycle power plant. Phase one of this effort is currently underway and the next phase is expected to start in the next one to three years. One unique element of this WESTCARB grant team is that to obtain the grant from U.S. DOE, the Energy Commission must select a team of partners including industry partners when submitting the grant. This grant is competitively reviewed and scored by U.S. DOE and if awarded, normally some of the contracts that are used to execute the grant are sole source contracts with commercial contractors.

The Department of Defense (U.S. DOD) is currently pursuing the most aggressive clean energy goals of any federal or state agency in converting its state-side bases to high levels of renewable penetration (50 percent), aggressively installing new energy efficiency technologies (for both existing and new facilities), and the transition of its non-tactical vehicle fleet from fossil-fuel based to all electric. There are more than 30 U.S. DOD locations in California and the opportunity for co-funding and cost share projects is significant. For example, the U.S. DOD is currently planning its first regional roll out of electric vehicle transition at several California bases over the next few years. This creates a strong opportunity to cost share the research, deployment and implementation of this critical technology. Additionally, California companies that can become part of the regional roll out in California will have business opportunities throughout the nation and the world as the U.S. DOD completes its system-wide transition to electric vehicles.

CHAPTER 4:
Technology Demonstration and Deployment



The applied research and development stage develops novel clean energy technologies and strategies, evaluates technical performance, and tests promising prototypes. The next step, technology demonstration and development, aims to evaluate the performance and cost-effectiveness of these technologies at or near commercial scale.

Through the Technology Demonstration and Deployment program area, the Energy Commission will provide funding for activities to test scalability and preliminary operating issues, bringing promising technologies and strategies closer to market. For this three-year investment plan, the Energy Commission will provide $129.9 million for technology demonstration and deployment funding to test new technologies in conditions that approximate real-world applications. A minimum of $27 million will be targeted specifically to bioenergy technology demonstration and deployment projects.

Building on the Applied Research and Development initiatives, the Technology Demonstration and Deployment program will also facilitate the achievement of the states' energy policy

priorities, including the "loading order." Demonstration projects funded in this category will also serve as a test bed to explore opportunities to make the whole better than the sum of individual parts through a holistic approach to integrating efficiency, renewables, and clean transportation. The potential benefits are improved customer choice, lower costs achievement of energy goals, and a better interface with the "smart grid."

Demonstration and deployment activities will typically be conducted in IOU service territories. However, projects located outside IOU service territories may be considered, if there is a strong case that the project demonstrates IOU electricity ratepayer benefits. The demonstration and deployment strategic objectives discussed below outline a set of initiatives focused on a particular proposal area. The strategic objectives are:

- S11: Demonstrate and evaluate the technical and economic performance of emerging efficiency and demand-side management technologies and strategies in major end-use sectors.
- S12: Demonstrate and evaluate clean energy generation technologies, including strategies to enhance grid integration of intermittent renewable energy resources.
- S13: Expand the development of energy smart communities through technology deployment strategies using renewable-based microgrids and the smart grid.

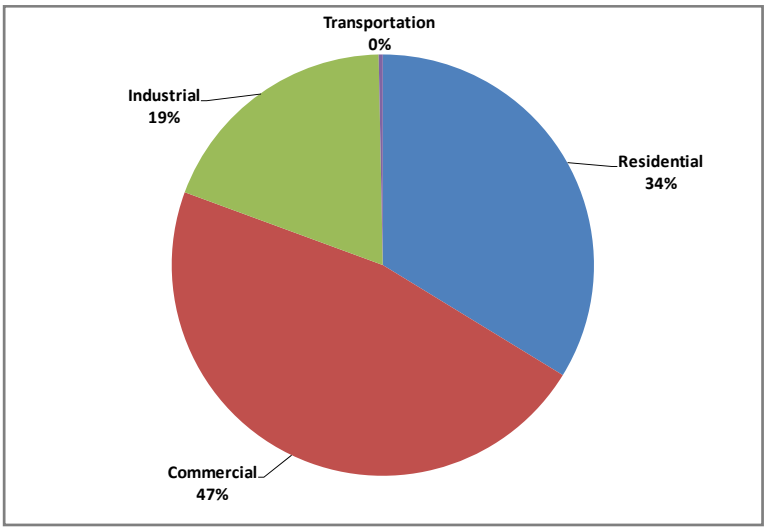
S11 Strategic Objective: Demonstrate and Evaluate the Technical and Economic Performance of Emerging Efficiency and Demand-Side Management Technologies and Strategies in Major End-Use Sectors.

Table 12: Ratepayer Benefits Summary Table for Strategic Objective 11

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S11.1 Identify and Demonstrate Promising Energy Efficiency and Demand Response Technologies Suitable for Commercialization And Utility Rebate Programs.	X	X		X	X			X	X
S11.2 Demonstrate Whole Building Retrofits – Using Emerging Efficiency Technologies - for Residential and Commercial Buildings to Achieve Targets Identified in the California Long-Term Energy Efficiency Strategic Plan and AB 758.	X	X		X	X			X	X

The State of California has recognized energy efficiency as a primary strategy to reduce the state's energy use and costs, as well as greenhouse gas emissions. Electricity used in homes, commercial buildings, industrial and agricultural processes and water and wastewater activities consume nearly 258 billion kWh/year in annual electricity use. Once technologies have been successfully demonstrated in bench scale systems, and meet pre-defined performance targets, they must be fully demonstrated in commercial settings at an appropriate scale "real-world" conditions to validate energy, water and cost savings, environmental parameters, overall economics (including operational and maintenance costs) and other criterions necessary to commercialize the technology/strategy and gain public acceptance. In addition to energy savings, some customers, especially industries, are highly sensitive to the reliability and quality of electric power. Therefore, in addition to improving energy efficiency, these demonstrations must also address power quality, supply and reliability issues as they improve energy efficiency or energy demand.

Figure 4: California's Electricity Consumption by Sector (total 258,000 million kWh/yr)



Source: United States Energy Information Administration (EIA), 2010

The focus of the initiatives in this section are to demonstrate emerging technologies that will result in electricity and cost savings, and economic and environmental benefits to California through peak load reduction and/or reduced energy consumption. These demonstrations will help solve specific problems associated with maximizing energy efficiency in existing facilities and processes. Facilities can include buildings and associated structures, industrial, agriculture and water processes.

S11.1 Proposed Funding Initiative: Identify and Demonstrate Promising Energy Efficiency and Demand Response Technologies Suitable for Commercialization and Utility Rebate Programs.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X					X

Issue: There are emerging technologies that can help California's end-use electricity sectors reduce their energy consumption, emissions, and/or water use, in environmentally sustainable ways, while maintaining productivity and safety. However, a significant portion of these emerging technologies have yet to be proven (demonstrated) at commercial or industrial scales in "real-world" conditions. They are in need of an independent assessment of their performance, overall economics, reliability, life-cycle cost and energy savings. Without an independent assessment of their technical and economic viability, these technologies do not make it past the "commercialization valley of death."

Purpose: This initiative will demonstrate emerging technologies that are past the "proof-of-concept" stage in building, industrial, agricultural, water or wastewater plant settings, including support for smart charging technologies for plug-in electric vehicles. These demonstrations will be partially funded by EPIC and the applicants will need to provide a required level of matching funds. The objective is to produce proven technical and economic performance data, which could make the technologies eligible to participate in the utilities' energy efficiency rebate programs and could facilitate the successful deployment of the technologies into the marketplace. Utility rebates can expedite customer acceptance and market development for the demonstrated technologies. Examples of technologies include those that can be used in:

- Buildings, such as lighting, heating and cooling systems and controls,
- Industrial, agricultural, water or wastewater sectors, including data centers, pre and post harvesting agricultural operations, water and wastewater treatment, conveyance and distribution and customer-side energy storage

Background: The Energy Commission's past successes with demonstration activities include the State Partnership for Energy Efficient Demonstrations (SPEED), which focused primarily on demonstrations with public university and State of California buildings, and the Emerging Technology Demonstration Grant Program which focused primarily on industrial, agriculture and water processes. The SPEED program has resulted in widespread application and installation of emerging technologies, especially lighting improvements and HVAC controls, in

several University of California and state buildings and has saved an estimated 61 million kWh/year and 4.2 million therms/year, resulting in $12 million per year in savings.[39] Additionally, other efforts also resulted in demonstrations of whole building energy efficiency concepts in limited residential and commercial buildings in a few climate zones. This initiative will expand these commercial demonstrations and emphasize large scale demonstration and deployment of advanced technologies to private and other publicly owned buildings.

This initiative will build and expand upon energy efficiency research efforts to demonstrate advanced technologies in some of the major energy using sectors, such as food processing, electrical and electronics, chemical industry, and water and irrigation. The focus will be on large-scale demonstrations and deployment and will involve multiple industrial players, such as investor owned utilities, major manufacturers and industrial customers, regulators and leading non-profit research institutions. These larger scale activities can result in quicker market adoption of the technology.

S11.2 Proposed Funding Initiative: Demonstrate Whole Building Retrofits – Using Emerging Efficiency Technologies – For Residential and Commercial Buildings to Achieve Targets Identified in the California Long-Term Energy Efficiency Strategic Plan And AB 758.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X					X

Issue: Building owners need to see actual, verified savings and mechanisms before they will finance whole building retrofit energy savings measures. They also need to understand system installation and commissioning practices for new systems before savings are achieved. Without that knowledge, building owners will hesitate to perform the retrofit. A lack of centralized information for building owners and professionals to educate themselves about cost effective retrofit measures, certification and financing programs for existing buildings and potential savings is one reason for a gap between building owner knowledge and emerging industry technology. Currently, the responsibility lies with the building owner or energy consultant to seek out the necessary technology and financing avenues. Without an implementation mechanism that can demonstrate and verify savings, provide the necessary funding and marketing, there is little incentive to building owners to retrofit their buildings.

39 2012 State Partnership for Energy Efficient Program, Draft final report.

Purpose: The *California Long Term Energy Efficiency Strategic Plan* requires energy consumption in existing homes and commercial building to be reduced by 40 percent by 2020 and 50 percent by 2030 respectively. The initiative will demonstrate and evaluate emerging efficiency technologies and retrofit strategies to achieve these targets. Special attention will be made to demonstrate the actual energy efficiency improvements achieved through integrated whole building retrofits. This initiative will seek to achieve these savings through integrated whole building retrofits to:

- Demonstrate and deploy performance-verified cost-effective whole building retrofits with third party monitoring and verification of benefits and commissioning of energy efficiency measures such as advanced heating, cooling and ventilation, ground source heat pumps, lighting, plug load efficiencies, building envelopes and domestic hot water systems, building energy management controls, and integration of renewable energy and storage systems.
- Develop and evaluate pilot programs for innovative financing mechanisms for whole building retrofits.
- Create an information repository/hub for building professionals and trades to share energy efficiency and renewable energy system information and experiences based on demonstration and deployment results.

Background: Nearly 60 percent of California's housing stock (and a comparable percentage of California's nonresidential building stock) was built prior to the existence of Building Energy Efficiency Standards. Accordingly, substantial energy efficiency improvements are needed in many of California's existing buildings.

This initiative will complement the work undertaken through the Energy Upgrade California Program, other Energy Commission building efficiency retrofit programs and AB 758, (Skinner, Chapter 470, Statutes of 2009). The Energy Upgrade California Program is collaboration between the California Energy Commission, the Public Utilities Commission, utilities, local governments, non-governmental organizations and the private sector to promote and finance energy efficiency and renewable energy projects for homes and businesses. Other Energy Commission building efficiency retrofit programs include the Bright Schools, Energy Partnership and low interest loan program. The focus on these programs is the use of conventional technologies and not emerging technologies. AB 758 requires the Energy Commission to develop and implement a comprehensive program to achieve greater energy savings in the state's existing residential and nonresidential building stock. The program is comprised of a complimentary portfolio of techniques, applications, and practices that will achieve greater energy efficiency in existing residential and nonresidential structures especially those that fall significantly below the efficiency required by the current California Building Energy Efficiency Standards (Title 24, Part 6). The proposed comprehensive program includes meaningful and reliable building energy assessments, energy benchmarks, building energy use

ratings and labels, cost-effective energy efficiency improvements, public and private sector energy efficiency financing, public outreach and education and green workforce training. The bill directs the Energy Commission to consider these components when developing the program, as well as other factors and strategies that the Energy Commission deems appropriate. These improvements will result in major energy savings that are important to California's economy and environment, particularly due to the air quality and water resource impacts of power plants, energy bill impacts of unnecessary electricity and natural gas use, and California's efforts to mitigate climate change through greenhouse gas (GHG) emission reductions.

S12 Strategic Objective: Demonstrate and Evaluate Clean Energy Generation Technologies, Including Strategies to Enhance Grid Integration of Intermittent Renewable Energy Resources.

Table 13: Ratepayer Benefits Summary Table for Strategic Objective 12

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S12.1 Demonstrate and Appraise the Operational and Performance Characteristics of Pre-Commercial Biomass Conversion Technologies, Generation Systems, and Development Strategies.	X	X	X	X	X		X	X	X
S12.2 Demonstrate and Deploy Pre-Commercial Technologies and Strategies for Combined Heat and Power Applications.	X	X	X	X	X		X	X	X
S12.3 Demonstrate and Deploy Technologies and Strategies to Improve Integration of Intermittent Renewable Energy.	X	X		X	X		X	X	X

As mentioned in Chapter 3, renewable energy and combined heat and power can provide numerous benefits to ratepayers. However, current market offerings for renewables and combined heat and power are typically more expensive than conventional generation. A number of innovative technologies and strategies are currently being developed that can increase the market viability of clean generation. These technologies need to be proven at or near commercial scales in real-world conditions to reduce their perceived risk to potential investors and customers.

As directed by the CPUC EPIC decision, a minimum of twenty percent of the technology demonstration and deployment funds will be allocated to biomass-to-electricity projects. Most of the solicitations in this are will fall within the scope of initiative S12.1.

S12.1 Proposed Funding Initiative: Demonstrate and Appraise the Operational and Performance Characteristics of Pre-Commercial Biomass Conversion Technologies, Generation Systems, and Development Strategies.[40]

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
	X	X			X		

Issue: Biopower technologies, as described in chapter 3, have a variety of challenges limiting full-scale deployment. The Energy Commission has held a number of public workshops to identify and address these challenges through the Bioenergy Action Plan. [41] [42] This initiative will not address every challenge facing the industry; rather, support will focus on demonstration and deployment activities that address the highest priority issues as identified by stakeholders. A summary of the issues that will be addressed through this initiative include:

- Air quality standards within the San Joaquin and South Coast air districts necessitate the demonstration and deployment of advanced pollution control equipment and low-emission generators that have demonstrated the ability to meet air quality standards at pilot scale. In addition, cost effective compliance technologies and mitigation measures

40 Initiative supported by stakeholder comments from Joint Comment Letter on Behalf of: California ReLeaf, California Urban Forests Council, Planning and Conservation League, Trust for Public Land, and American Planning Association (APA) California Chapter; Waste Management; Placer County Air Pollution Control District (PCAPCD); Agricultural Energy Consumers Association; Pacific Forest Trust; John A. Paoluccio, CNFbiofuel; Bay Area Biosolids to Energy (BAB2E) submitted by Delta Diablo Sanitation District

41 For a detailed list of the challenges limiting bioenergy development, please see O'Neill, Garry, John Nuffer. 2011. *2011 Bioenergy Action Plan*. California Energy Commission, Efficiency and Renewables Division. Publication number: CEC-300-2011-001-CTF.

42 O'Neill, Garry. 2012. *2012 Bioenergy Action Plan*. California Energy Commission, Efficiency and Renewables Division.

are needed to commercially deploy bioenergy systems.[43] U.S. EPA's rule for toxic and hazardous air pollution may pose a challenge for existing solid-fuel biomass facilities, particularly with respect the hydrogen chloride emissions. [44]

- Biomass feedstock costs are directly correlated to the transportation distance, which necessitates size constraints for new facilities, generally to less than 10 megawatts. To harness the economies of scale that larger projects can provide, new fuel handling systems or technologies that reduce the transportation costs of biomass feedstocks must be demonstrated at market scales.
- Within the dairy industry, the dairy market and the perceived technical risk of on-farm biopower systems have made financing and development of pre-commercial systems difficult and expensive.[45]
- Challenges specific to thermochemical conversion technologies and generation systems include high capital cost, and the need for demonstration facilities to assess air emissions, cost, and reliability of downstream gas treatment and catalyst systems.[46]

Purpose: This initiative will advance pre-commercial technology demonstration and early-stage deployment of biopower and biogas technologies and systems. The types of demonstration and deployment projects that the Energy Commission will consider in this initiative include community-scale bioenergy facilities in agricultural, forest or wildland, and urban regions, and low-emission or zero emission distributed generation technologies including CHP, CCHP, and other integrated systems. The overall goal of this initiative is to address issues limiting full-scale deployment and develop publicly available data on the operational characteristics of these technologies and best practices to reduce the overall cost of generation.

Technology demonstration and deployment projects in this area will need substantial funding to overcome the challenges we have identified. Therefore, to maximize the effect of EPIC investments in this area, this initiative will focus on the following areas:

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43 Economic Feasibility of Dairy Manure and Co-Digester Facilities in the Central Valley of California. May 2011. Prepared for the California Regional Water Quality Control Board, Central Valley Region by Environmental Science Associates.

44 California has higher than average chloride concentrations compared to the rest of the US. Reasons include proximity to high concentrations of chloride in the ocean and irrigated regions with high salinity. Chloride that is absorbed by vegetation can be transformed to HCl during combustion.

45 *Economic Feasibility of Dairy Manure and Co-Digester Facilities in the Central Valley of California*. May 2011. Prepared for the California Regional Water Quality Control Board, Central Valley Region by Environmental Science Associates.

46 O'Neill, Garry, John Nuffer. 2011. *2011 Bioenergy Action Plan.* California Energy Commission, Efficiency and Renewables Division. Publication number: CEC-300-2011-001-CTF.

- Agricultural-based and community-scale bioenergy technologies and systems including anaerobic digesters, thermochemical conversion, advanced pollution controls, and ultra low emission generation technologies capable of meeting local air quality standards. This initiative may fund the demonstration of new ownership models for on-farm energy generators including multi-farm cooperatives or third-party ownership.[47]
- For systems near urban and wildland interface regions, focus will be on demonstrating community-scale thermochemical conversion and low-emission generation systems that will use locally sourced biomass, primarily from fire prevention activities.
- Demonstrate advanced biomass fuel handling and delivery systems or strategies that have shown to be economically feasible.
- Demonstration of pre-commercial integrated systems that combine biopower technologies with other processes (including waste management, composting, and recycling) into a single location.
- Demonstration and deployment of pre-commercial biopower systems on state lands within the territory of an investor owned utility.

Background: Although many of the core digester technologies have been established on a global scale, these systems have not reached commercial maturity for use in agricultural and urban waste settings (with the exception of wastewater applications) in California. Technology demonstrations that could dramatically improve future on-farm bioenergy adoption include cost-effective low-emission internal combustion engines, micro-turbines or fuel cells, inexpensive emissions control technologies, or efficient biogas upgrading systems with low-pressure pipeline injection.[48] [49]

Recently, a federal grant was provided to assess the feasibility of a centralized dairy digester model. This study advances this conceptual model and lays the foundation for development of centralized dairy digester projects in California.[50] The feasibility study is scheduled for completion by the second quarter of 2013.

47 Cooperative Approaches for Implementation of Dairy Manure Digesters. http://www.rurdev.usda.gov/rbs/pub/RR217.pdf

48 *Economic Feasibility of Dairy Manure and Co-Digester Facilities in the Central Valley of California*. May 2011. Prepared for the California Regional Water Quality Control Board, Central Valley Region by Environmental Science Associates.

49 *Advanced Technology to Meet California's Climate Goals: Opportunities, Barriers & Policy Solutions.* ETAAC Advanced Technology Sub-Group. December 14, 2009. Pages 4-11.

50 http://www.calepa.ca.gov/Digester/Documents/CentDigStudy.pdf.

The Energy Commission has provided funding to develop many biopower projects, including demonstration and testing of advanced biological and thermochemical conversion technologies at a variety of settings in California. These projects have shown that additional demonstrations and early stage deployment projects are needed to bring down the development costs and improve environmental compliance of these technologies.

One particular program provided a key insight in future biopower demonstration projects. The Dairy Power Production Program primarily focused on demonstrating on-farm dairy digester projects in the San Joaquin Valley. Projects funded by this program encountered a changing regulatory environment, including increasingly stringent air emissions standards. Unaware that emissions standards were under review by the local air district, projects purchased generation equipment based on emissions limits that would no longer be in effect when installed two years later. A key lesson learned from the implementation of this program is that demonstration solicitations should require the involvement of local regulatory agencies at an early stage to ensure that projects are designed to meet regulations in effect when the project begins operating. [51] [52]

On December 15, 2010, the Energy Commission adopted a memorandum of understanding (MOU) between the Energy Commission and the Departments of General Services, Corrections and Rehabilitation, Transportation, Water Resources, and Fish and Game "to facilitate the development of renewable energy projects on state buildings, properties, and rights-of-way." Under this MOU, the agencies, among other things, will collaboratively study, plan, and develop electricity infrastructure and to develop statewide request-for-proposals to make these properties available to interested developers. "These agencies have the experience and resources necessary to perform the additional evaluations and environmental screening needed to determine which state-owned buildings, lands, and rights-of-way are most appropriate for renewable development going forward. The aim is to develop renewable resources on state property through existing programs and at no net increase in cost to the state." Energy Commission staff recommends that the state install 2,500 MW of renewable energy on state-owned property by 2020. EPIC funds can further this cause through targeting demonstration and deployment projects on pre-screened public lands.[53]

There are a number of other grant opportunities for the demonstration of biomass to energy systems, including:

51 http://www.calepa.ca.gov/digester/History.htm.

52 *Dairy Power Production Program Dairy Methane Digester System Program Evaluation Report*. Western United Resource Development, Inc. February 2009. CEC-500-2009-009.

53 Barker, Kevin, Jim Bartridge, Heather Raitt. 2011. Developing Renewable Generation on State Property, California Energy Commission. Publication number: CEC-150-2011-001.

- U.S. Department of Agriculture (USDA) Rural Business Opportunity Grants (RBOG): The primary objective of the RBOG program is to promote sustainable economic development in rural communities with exceptional needs. On-farm bioenergy is eligible for grants under this program. EPIC funding can leverage additional federal funding in this category.
- USDA Rural Energy for America Program (REAP): This program assists agricultural producers and rural small businesses to complete a variety of projects. Offering both loan guarantees and grants, the REAP program helps eligible applicants install renewable energy systems such as solar panels or anaerobic digesters, make energy efficiency improvements such as installing irrigation pumps or replacing ventilation systems, and conduct energy audits and feasibility studies. EPIC funding can leverage additional federal funding in this category.
- Biomass Research and Development Initiative (BRDI)—a joint program through USDA and the U.S. Energy Department (U.S. DOE)—will help develop economically and environmentally sustainable sources of renewable biomass. The focus of this funding program is on development of transportation biofuels. However, funding in this program for feedstock development activities may overlap some EPIC funded projects. EPIC staff will monitor this program for opportunities to leverage funds.

S12.2 Proposed Funding Initiative: Demonstrate and Deploy Pre-Commercial Technologies and Strategies for Combined Heat and Power Applications.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X			X		X

Issues: Upfront purchase and installation costs and other barriers have limited the market penetration for combined heat and power technologies despite their system-wide benefits. Combined heat and power systems have an estimated total technical potential of more than 18,000 mega-watts in California, yet an Energy Commission-funded study estimates only 2,988 mega-watts will be installed by 2029 under a base case scenario. New technological innovations are emerging that could significantly increase the market penetration of combined heat and power. However, these technologies have not been deployed at sufficient scales to prove their commercial viability and acceptance, and drive down installation and maintenance costs. More demonstration and early deployment projects are needed to further increase their market competitiveness.

Purpose: Through this initiative, funding will be provided to demonstrate new technologies and approaches to advance the economic and environmental performance of combined heat and power systems (CHP) systems using both renewable and fossil fuel sources. There are significant opportunities to demonstrate and deploy promising CHP/CCHP systems customized for industrial and institutional settings such as food processing plants, manufacturing facilities, hotels, hospitals and wastewater treatment plants. EPIC investments should be used to demonstrate and evaluate the value that CHP and CCHP systems such as these can provide to customers and California as a whole.

This initiative will focus on the following demonstration activities:

- Demonstration of low-emission or zero emission prime mover technologies or emission control equipment. This will be coordinated with other similar demonstration projects to avoid duplication.
- Demonstration of advanced CHP/CCHP technologies on state property.
- Deploy innovative CHP technologies at utility scale and assess the installation costs and develop strategies to address.

Background: There are a number of funding opportunities for CHP systems, including incentives, grants, and feed-in tariff pricing mechanisms. Funding in this initiative will be used to fill identified gaps in funding for demonstration projects in California without duplicating in-state incentive programs such as the Self Generation Incentive Program.

Current funding programs:

- Self Generation Incentive Program, administered by the IOUs, provides incentives for qualifying distributed energy systems installed on the customer's side of the utility meter. Qualifying technologies include wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems.[54]
- Feed-in Tariffs for Highly Efficient CHP: This FIT provides standard offer contracts for purchase of excess electricity from eligible combined heat and power (CHP) systems by an electrical corporation under Assembly Bill 1613. A standard contract will be available to all eligible CHP systems up to 20 megawatts and a simplified contract will be available to CHP systems that export no more than 5 megawatts.[55]

54 http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/

55 http://www.cpuc.ca.gov/PUC/energy/Climate+Change/chpfeedin.htm

- Financial Funding Assistance for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (SBTT) for U.S. DOE:[56] A step-by-step grant program that is covering multiple types of renewable energy.[57] CA companies have been successful in the past entering the program. Restrictions on the type of eligible projects limit effectiveness of the program for developing innovative ideas.

S12.3 Proposed Funding Initiative: Demonstrate and Deploy Technologies and Strategies to Improve Integration of Intermittent Renewable Energy.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X	X		X

Issues: The intermittent nature of renewable resources, such as wind and solar, results in variable and sometimes unpredictable electricity generation; high intermittency can cause major problems for grid operators, including potentially costly outages. Technologies, such as energy storage and demand response (DR), have the potential to mitigate the intermittency effects of renewable generation. However, pre-commercial storage technologies have not been demonstrated and deployed at scales sufficient to establish a business case for these technologies. DR applications have so far been limited in scope to pilot demonstrations, and require full-scale field demonstrations to evaluate the overall value that DR can provide to renewables integration at the grid level and in microgrid applications.

Both energy storage technologies and demand response strategies can provide the ability to mitigate variable renewable energy generation. There is currently research being conducted on the development of a wide variety of energy storage technologies; there is also existing research to advance demand response technologies and strategies. However, the synergies between these two approaches have yet to be fully explored. Integrated packages of energy storage and AutoDR can potentially reduce the overall cost to the state by 20 to 40 percent[58]. Further demonstrations are needed to not only advance economies of scale for both DR and energy storage, but also to determine best practices for the interplay of both of these technologies to establish a business case for real-world applications.

56 http://science.energy.gov/sbir/about/

57 http://science.doe.gov/grants/pdf/SC_FOA_0000628.pdf (example from 2012 that wanted to possibly sponsor offshore wind mooring technology)

58 2011 PIER Annual Report. Page 47. CEC-500-2012-003-CMF, March 2012

Purpose: This initiative will demonstrate and evaluate approaches to advance the integration of intermittent renewable energy into California's grid. Focus will be placed on technologies and strategies to demonstrate potential business cases for energy storage and demand response. Pre-commercial energy storage technologies will be demonstrated to evaluate technical and economic feasibility, and opportunities optimize storage deployment will be evaluated. Energy storage technologies will include bulk energy storage systems, such as pumped hydro, plant-level TES, and compressed air energy storage,[59] and modular energy storage, such as batteries and flywheels. A variety of renewable generation, energy storage, and DR configuration will be demonstrated and evaluated to determine optimum levels for each. Furthermore, this initiative will examine potential demonstrations of energy storage integrated with hybrid renewable energy systems (more than one renewable resource) and demand response, to cost-effectively provide baseload or near-baseload generation from intermittent renewables.

Background: The Energy Commission has funded a number of projects to advance energy storage. Through the American Recovery and Reinvestment Act (ARRA), a significant number of Energy Storage demonstration projects were funded in California. The U.S. DOE provided $151.5 million in ARRA funds. The Energy Commission is providing $6.44 million as cost-share funds for these projects. The recipients are contributing $477.5 million out of total cost of $635.46 million for these projects. In addition, the Energy Commission in 2010-2011 funded $8.97 million to support several non-ARRA Energy Storage projects. For a listing of all of these projects, please see *2020 Strategic Analysis of Energy Storage in California,* publication CEC-500-2011-047. November 2011.

The U.S. DOE has also invested in the development of advanced energy storage technologies. Programs such as the advanced research projects agency – energy (ARPA-E) have developed and evaluated a variety of energy storage technologies and innovative applications. Through the Grid-Scale Rampable Intermittent Dispatchable Storage (GRIDS) program alone, ARPA-E invested $27.7 million in 12 projects to develop and bring to market a wide variety of innovative energy storage technology designs. However, most of these developed technologies have yet to be widely deployed due to high system costs.

The Demand Response Research Center (DRRC) at Lawrence Berkeley Lab, established with Energy Commission funding in 2004, conducts research that advances the near-term adoption of demand response (DR) technologies, policies, programs, strategies and practices. One of the major accomplishments of the DRRC is the development and commercialization of open automated demand response communications technology. Other significant advances have

59 Andris Abele, Ethan Elkind, Jessica Intrator, Byron Washom, et al (University of California, Berkeley School of Law; University of California, Los Angeles; and University of California, San Diego) 2011, *2020 Strategic Analysis of Energy Storage in California*, California Energy Commission. Publication Number: CEC-500-2011-047.

been made by this research center that will inform the next generation of DR technologies and deployment strategies. Further research efforts will expand on the advances made in both demand response and energy storage technologies, to develop and demonstrate integrated packages of DR and energy storage to cost-effectively enable increasing penetrations of intermittent renewables into California's grid.

S13 Strategic Objective: Expand the Development of Energy Smart Communities Through Technology Deployment Strategies Using Renewable-Based Microgrids and the Smart Grid.

Table 14: Ratepayer Benefits Summary Table for Strategic Objective 13

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S13.1 Demonstrate Zero-Net Energy Buildings and Communities.	X	X		X		X	X		
S13.2 Demonstrate Renewable Energy-Based Microgrids Capable Of Sharing Resources Across the Larger Power Grid.	X	X	X	X		X	X		
S13.3 Demonstrate Advanced Vehicle-to-Grid Energy Storage Technologies and Second-Use Vehicle Battery Applications.	X			X	X	X			

Energy-smart communities are state-of-the-art communities in which energy is supplied primarily from locally-available renewable energy resources, with the possibility of providing excess energy back to the grid. These communities also include near-zero or zero-net energy buildings, local clean energy generation systems and the integration of electric transportation infrastructure, thereby providing economic and environmental benefits to local ratepayers. Furthermore, energy-smart communities can potentially offer an additional value to electricity utilities by providing localized power generation and management of local community demand.

To achieve California's ambitious renewable energy and greenhouse gas reduction goals, a coordinated effort will be required at local and regional levels. These initiatives will serve as community showcases of cutting edge technologies, system components, and integration

strategies. Energy smart community demonstrations will involve advanced and emerging energy technologies across the electricity value chain, including efficiency, renewables, energy storage, advanced communications, and intelligent grid-operation technologies to evaluate technical potential and economic performance in real-world community environments. Potential systems designs, deployment strategies and ownership models will be evaluated for their cost-effectiveness and ability to be replicated throughout California.

Successful demonstration of projects funded under this objective would increase consumer, industry, and utility confidence in energy smart community strategies and serve as a showcase for similar business parks, neighborhoods, and facilities across IOU territories. These demonstrations will help develop innovative partnerships, business models, and permitting processes that accelerate achievement of our clean energy policy goals through energy smart communities. The primary goal of the following initiatives is to determine how to best design, build and integrate ZNE buildings and community in the most cost-beneficial manner that also will be adopted in the marketplace.

S13.1 Proposed Funding Initiative: Demonstrate Zero-Net Energy Buildings and Communities.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X	X	X	X

Issue: The primary barrier to ZNE buildings and communities is the cost of required technologies and components. Also, the deployment of distributed renewables, such as wind and solar, results in a variable local energy generation profile and increases the need for local ancillary services. Current building-scale ZNE solutions may not take advantage of the full range of benefits offered by community energy systems. While ZNE communities are technically possible at this time, previous demonstration attempts have encountered a number of issues that hinder their success.

The inadequate supply of builders and developers that have the skills and experience to create ZNE buildings and communities is a barrier. Many design challenges and site-specific considerations are required to efficiently meet the energy needs of a building and the surrounding community. Designers must apply holistic design principles and take advantage of the free, naturally occurring assets available, such as passive solar orientation, natural ventilation, daylighting, thermal mass, and nighttime cooling. Without properly trained builders and developers to create ZNE buildings and communities, new technologies will never

reach market maturation due to the lack of exposure or poor performance related to incorrect designs and installations.

Lack of a long term financing mechanism, such as the PACE program in California, which allowed current building owners to pass forward loan payments for energy retrofits to new owners when homes are sold, can be a barrier to the goal of ZNE buildings. Financing opportunities are especially critical to low-income qualified buildings, which make up a large percentage of multi-unit dwellings. The limited availability of financing and incentive options prohibit builders from realizing any payback from new building or retrofitting a building.

Purpose: This initiative will demonstrate and verify designs and approaches for the cost-effective integration of localized energy generation, efficiency, and systems technologies into community environments to enable ZNE buildings and communities. This initiative can include demonstrations of ZNE buildings, communities or a combination of both. Verified models and tools can then be utilized by local developers to minimize energy costs and maximize ratepayer benefits realized by deploying ZNE systems.

Potential activities can include:

- Demonstrate advanced energy efficiency technologies, strategies and controls to reduce building and/or community level electricity use and demand.
- Design, implement, monitor and verify advanced clean energy generation and efficiency components, systems and integration system performance and benefits.
- Examine integration strategies across residential, industrial, commercial, institutional, and governmental facilities and buildings to enable economically-viable, fully-operational net-zero energy business parks, shopping centers, institutional facilities and communities.
- Demonstrate novel approaches to achieve high penetration deployment of DG technologies, smart grid technologies, distributed energy storage, and electric transportation infrastructure in industrial, commercial, residential and mixed-use community developments.
- Develop and evaluate innovative financing mechanisms for ZNE buildings and communities.
- Increase knowledge, skills and experience by builders and designers to create ZNE buildings or communities
- Increase knowledge of the human behavior characteristics associated with ZNE buildings and communities, and what barriers must be overcome for widespread adoption based on post monitoring of ZNE buildings or community demonstrations.

- Analyze and evaluate the potential of a "phased approach" to ZNE buildings or communities, such as assessing and establishing intermediate ZNE goals (for example, 50 percent, 75 percent, 100 percent and evaluating technical/economic feasibility)
- Provide empirical data information in a common taxonomy for use by stakeholders, policymakers, consumers, and local governments through available software such as HERS and BEARS compatible with other energy/asset rating software systems. This is critically important to allow various ZNE case studies to be compared with common metrics.

Background: The California Public Utilities Commission's Long Term Energy Efficiency Strategic Plan has established big bold initiatives to achieve residential and commercial ZNE in new construction by 2020 and 2030 respectively. Zero-net energy buildings have been demonstrated in both commercial and residential buildings in California. In addition, early adopter institutions, facilities, and neighborhoods in California are implementing zero- or near-zero energy approaches at the community scale. San Diego Gas & Electric currently operates an energy smart community demonstrating state-of-the-art technologies at Borrego Springs. The UC Davis West Village is the largest planned zero net energy community in the United States. However, the technical feasibility of ZNE buildings and communities is still in the early stages of demonstration. "Significant additional resources will be required to scales these efforts up for full scale production at affordable prices" [60]

S13.2 Proposed Funding Initiative: Demonstrate Renewable Energy-Based Microgrids Capable of Sharing Resources Across the Larger Power Grid.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X	X	X	X

Issue: Microgrids have emerged as a powerful infrastructure for a customer, or aggregation of customers, to integrate renewable resources and demand management strategies in a controlled environment, and when necessary, safely island and reconnect to the larger power grid. Renewable energy microgrids with decentralized management and control offer the benefits of increasing grid reliability, stability, and resiliency in the face of power outages.[61] However,

60 *California Energy Efficiency Strategic Plan*

61 EPRI, 1/30/2006. "Sustainable Communities—Business Opportunities for the Electric Utility Industry," http://my.epri.com/portal/server.pt?.

utilities and the California ISO lack the ability to monitor the operation of microgrids and coordinate the sharing of resources from one microgrid to another. Microgrid controllers are new and unproven. Many resources within a microgrid have yet to be operated as part of an integrated system. Plug-in electric vehicles have yet to be integrated as a resource within microgrids. Additionally, sharing resources across microgrids has never been demonstrated. Interest by the Department of Defense and others is high due to the benefits that shared resources can offer.

Purpose: The Energy Commission will fund microgrid demonstration projects to evaluate the potential of technology solutions and deployment strategies to minimize energy costs and provide electricity customer ratepayer benefits. EPIC-sponsored microgrid research will include activities to demonstrate and evaluate:

- Advanced microgrid control and operation techniques.
- Strategies for the coordination and sharing of resources of multiple regionally-separated microgrids.
- The interoperability of microgrid component technologies.
- The impacts and benefits of microgrid deployment on grid planning and operations.

Background: Microgrids are ideal for applications that **r**equire secure and uninterrupted energy supply, such as military installations, universities, hospitals, and prisons, and can help enable energy smart communities. Microgrids require the deployment and integration of a variety of onsite clean energy technologies to reliably and securely meet local energy demand. Additionally, microgrids need the ability to "island" or operate independently from the grid when needed. Switches are needed that can seamlessly transition from islanded mode to grid-synchronized operation on very short notice.

The Energy Commission has previously funded several microgrid demonstration efforts throughout California, including Santa Rita Jail in Alameda, Borrego Springs in SDG&E territory, and the University of California, San Diego. The Energy Commission will continue to work with the U.S. Department of Defense to develop microgrids for DOD facilities in California that will be capable of sharing resources. The intent is to lessen the impacts of these facilities on California's grid while helping DOD meet its renewable energy goal of 25 percent penetration by 2025.

S13.3 Proposed Funding Initiative: Demonstrate Advanced Vehicle-to-Grid Energy Storage Technologies and Second-Use Vehicle Battery Applications.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X		X	X

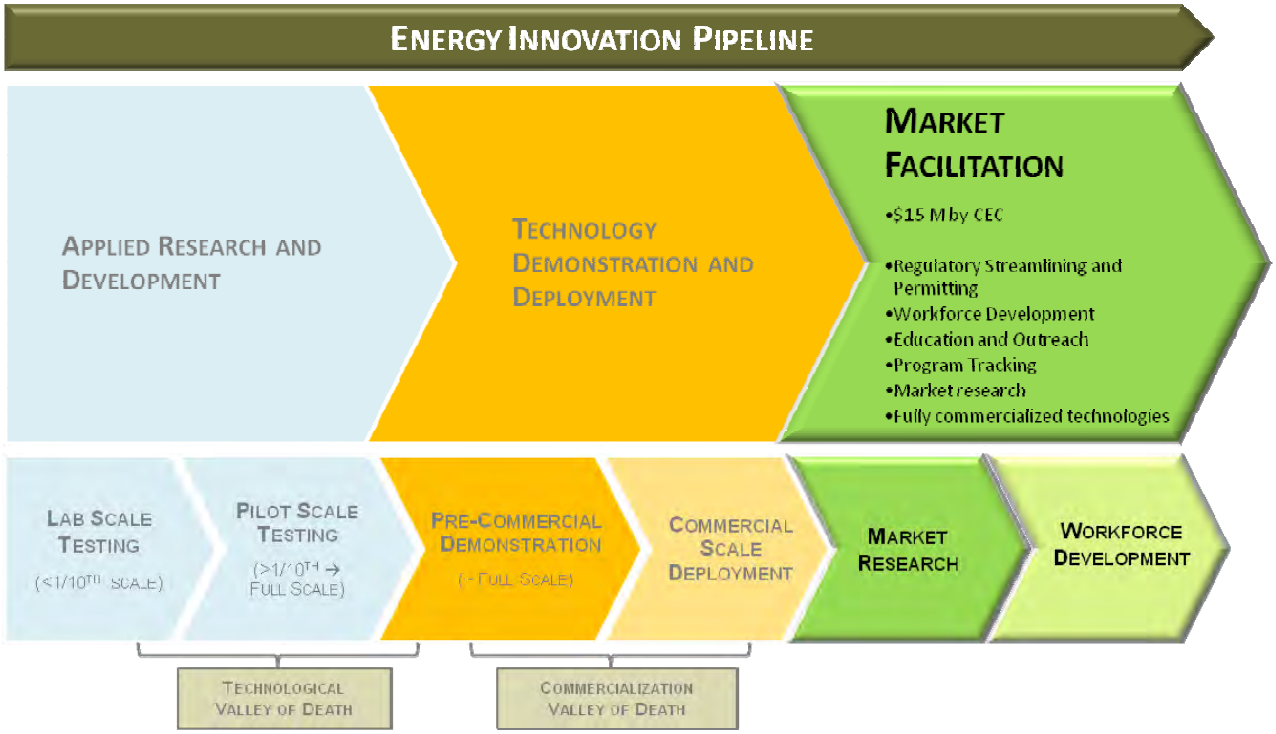
Issue: Vehicle-to-grid and second-life storage application systems require properly integrating numerous components including the vehicle, communication software, and utility and ISO signals. Demonstrations are needed to test that all the components are appropriately integrated and to address issues that may have an effect on distribution and transmission levels. Currently, this integration has not been demonstrated at scales sufficient to encourage fleet and facility operators to consider the deployment of vehicle-to-grid and second-life storage applications. Additionally, vehicle Original Equipment Manufacturers (OEMs) are concerned with potential implications of V2G on the vehicle battery pack and battery charging components.

Purpose: This initiative will demonstrate vehicle-to-grid and battery-second use applications at facilities located in IOU territories. Demonstrations of V2G and energy storage from stationary batteries (secondary use) are needed to test that all the components are successfully integrated, and to address issues that may exist at the distribution level and transmission level. This initiative will support demonstration efforts in various locations and fleet applications (commercial vehicle fleets as well as light-duty fleets), including, but not limited to ports, school bus facilities, utility facility yards, corporate distribution headquarters, post offices, military bases, and airports. The demonstrations will include methods to evaluate an address concerns regarding the application of V2G on battery packs and vehicle charging components. Furthermore, these demonstrations could help establish a business case for not only vehicle-to-grid and battery second-use applications, but also increased purchase of plug-in electric vehicles by fleet operators.

Background: There have been a few small scale demonstrations of vehicle-to-grid and second-life storage applications. For vehicle-to-grid, the Energy Commission is co-funding a project at LA Air Force base to demonstrate using medium-duty plug-in electric vehicles to provide grid ancillary services with the California ISO. Additionally, work is currently underway within DOD to conduct demonstrations at the MicroGrid level at military installations in Hawaii and Colorado. Work is also underway within the PJM Interconnect, BMW and the University of Delaware to demonstrate use of V2G. For battery-second use applications, the University of California, San Diego is currently conducting long-term testing of vehicle battery packs to better determine their suitability for grid applications. The University of California, Davis is

demonstrating the feasibility of a second-use device at the household level to provide demand-side management.

CHAPTER 5:
Market Facilitation



Through the Market Facilitation program area the Energy Commission will address funding gaps in market processes that drive clean energy investment within IOU service territories. For this three-year investment plan, the Energy Commission will provide $15 million annually for market facilitation funding initiatives that streamline regulatory processes and project permitting, help develop the state's clean energy workforce, fund education and outreach programs, and fund program tracking activities. Specifically the Energy Commission proposes the following areas of funding:

- Regulatory Assistance – Offer a combination of direct and indirect investments in IOU territories that facilitate clean energy development.
- Workforce Development and Education – Provide direct investments that help strengthen the wide variety of workforce development efforts in targeted communities.

- Program Tracking – Monitor and track progress or major changes within the clean energy industry to inform solicitation and project selection decisions for future EPIC Investment Plans.
- Market Research - Develop analytics on the clean energy market that include policy impact and policy opportunity assessments.

Each strategic objective below outlines a set of initiatives focused on a particular area of the proposed funding. The strategic objectives are:

- S14: Collaborate with local jurisdictions and stakeholder groups in IOU territories to establish strategies for enhancing current regulatory assistance and permit streamlining efforts that facilitate coordinated investments and wide-spread deployment of clean energy infrastructure
- S15: Strengthen the clean energy workforce by creating tools and resources that connect the clean energy industry to the labor market
- S16: Guide EPIC investments successfully through the clean energy technology innovation pipeline by connecting all stakeholder groups involved in the development, deployment, and integration stages

S14 Strategic Objective: Collaborate with Local Jurisdictions and Stakeholder Groups in IOU Territories to Establish Strategies for Enhancing Current Regulatory Assistance and Permit Streamlining Efforts that Facilitate Coordinated Investments and Wide-Spread Deployment of Clean Energy Infrastructure

Table 15: Ratepayer Benefits Summary Table for Strategic Objective 14

	Promoter Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S14.1 Pilot Demonstrations of Localized Energy Resource Markets.	X	X		X	X	X		X	X
S14.2 Provide Planning Grants to Cities and Counties to Incorporate Clean Energy Technology Planning and Permitting Processes into Local Government Land Use Planning	X	X		X	X			X	X
S14.3 Conduct a Local Government Needs Assessment Study That Identifies Regulatory Gaps Within Local Planning and Zoning Processes.	X	X		X	X			X	X
S14.4 Collaborate with Local Jurisdictions and Industry Stakeholders to Create Model Ordinances for Emerging Clean Energy Technologies.	X	X	X	X	X			X	X
S14.5 Provide Funding to Assist in the Development of the General Plan Guidelines.		X	X	X	X		X	X	X
S14.6 Develop Consensus Based Educational Materials for Local Officials Interested in Facilitating Clean Energy Market Growth.		X	X	X	X		X	X	X

Local governments play an important role in achieving California's short and long-term energy and climate goals. As the California Air Resources Board (CARB) explains in the AB 32 Scoping Plan, "Local governments are essential partners in achieving California's greenhouse gas reduction goals. They have broad influence and, in some cases, exclusive authority over significant emission sources through their planning and permitting processes, local ordinances, outreach and education efforts, and municipal operations."

Local government development policies that facilitate the appropriate deployment of clean energy technologies will help promote future grid reliability, by creating a more predictable and certain development environment for a variety of clean energy technologies. Moreover, investments in the distribution grid must be made to accommodate localized energy resources (LER). Demonstrations are needed to show how local government clean energy goals can be achieved by coordinating land use planning with distribution infrastructure information.

Most local government comprehensive plans do not include clean energy land uses. Most cities and counties are processing development applications for renewable energy projects outside of the traditional comprehensive planning process, which adds uncertainty to project development. This uncertainty can hamper grid reliability, increase development costs, and increase health and safety risks to IOU ratepayers.

Establishing uniform standards will provide more certainty and increased predictability, while also keeping costs low and protecting the health and safety of ratepayers.

The initiatives included in this objective invest in overcoming regulatory and permitting challenges at the local level. Investments in local governments are integral to the success of commercializing clean energy innovations.[62]

S14.1 Proposed Funding Initiative: Pilot Demonstrations of Localized Energy Resource Markets

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X	**X**		**X**	**X**	**X**	**X**	**X**

Issue: The Center for Law, Energy, and the Environment (CLEE) reports that high penetrations of Localized Energy Resource (LER) markets require coordination to address financial, regulatory, and technical barriers.[63] In CLEE's assessment, technical barriers refer to the

62 During the initial public workshops concerning the EPIC investment plan, the Energy Commission heard from several stakeholders that EPIC should invest in developing and allocating resources to local governments. Additionally, the Energy Commission received written comments supporting regulatory assistance from the following parties: Defenders of Wildlife, Communities Allied for Distributed Energy Resources, Pacific Forest Trust, Los Angeles Regional Collaborative for Climate Action and Sustainability, CALSTART, Joint Comment Letter from California ReLeaf, California Urban Forests Council, Planning and Conservation League, Trust for Public Land, and the California Chapter of the American Planning Association, and the California Center for Sustainable Energy.

63 http://www.law.berkeley.edu/files/ccelp/CA_Transition_to_Local_Renewable_Energy.pdf

constraints of the electric grid under high LER penetration and the regulatory barriers relate to the planning difficulties that local governments face as LER penetration increases. Southern California Edison submitted comments to the *2011 Integrated Energy Policy Report* proceeding recommending that utilities should help identify locations for LER to minimize system impacts and upgrade costs.[64]

Purpose: Pilot projects will demonstrate improved coordination of IOU distribution infrastructure, land-use planning and policies, existing state policies, clean energy incentives, and procurement markets in three locations, one in each IOU service territory. This initiative will demonstrate innovative strategies to achieve high penetrations of clean energy investment in locations that minimize system impacts and upgrade costs.

To achieve high penetrations of LER in the pilot projects, local government land use goals and utility infrastructure will leverage state and local policies with procurement programs to target areas where local governments and utilities prefer to locate renewable generators.

This initiative will solicit grant requests from regional consortiums of cities and counties to participate in a pilot strategy to develop LER markets and assess the technical LER potential for all clean energy technologies. Based on the technical review, the Energy Commission and IOUs will work with consortium grantees to communicate ideal interconnection points for LER generation. The Energy Commission will also work with IOUs to include planned and necessary grid upgrades in technical potential scenarios. Each consortium of cities and counties will compare IOU distribution infrastructure with existing and future land uses. The comparison should serve as a basis for selecting sites and implementing actions (including, but not limited to, General Plan amendment, zoning change, variances, ordinances, and map overlays) to facilitate a high penetration of LER on sites that integrate with the distribution grid and meet the needs of communities.

In each pilot project, the EPIC program administrators will work with consortium grantees to identify policies and incentives to use to develop clean energy markets that support high LER investment.

Background: Electric utilities, including California IOUs, consistently express concern that high penetrations of generation on the distribution system will hamper grid reliability, especially integration of intermittent renewable power. Governor Brown's goal of installing 12,000 megawatts of localized energy resources will require significant investments into the distribution grid. As CLEE reports, integrating large amounts of distributed generation into the distribution grid requires collaboration, especially collaboration between distribution grid operators and local governments. Through their Climate Action Plans and other consensus-

64 See Southern California Edison written comments to 2011 IEPR proceeding at: http://www.energy.ca.gov/2011_energypolicy/documents/comments_draft_iepr/SCEs_Comments_TN-63209.pdf

based plans, local governments have expressed a desire to increase renewable distributed generation within their communities. These local governments have set capacity targets for different renewable technologies. Also, they have indicated the land use and building types on which they prefer to see these technologies installed. However, these local governments have not coordinated identification of these areas and building types with the local electric distribution system.

S14.2 Proposed Funding Initiative: Provide Planning Grants to Cities and Counties to Incorporate Clean Energy Technology Planning and Permitting Processes into Local Government Land Use Planning.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X	X			X	X	X	

Issue: The Office of Planning and Research reports that a majority "of jurisdictions do not have policies, programs, or ordinances that facilitate the development of renewable energy facilities."[65] At the local government level, clean energy policies, programs, and ordinances are needed to achieve high penetrations of clean energy investment into cities and counties. In the clean energy market, local governments have exclusive authority over a variety of technologies through their land use power. To date, several proactive local governments across California have taken steps to create regulatory frameworks that facilitate the development of a variety of clean energy technologies. Most of these local efforts facilitate deployment of distributed solar PV, while some facilitate the deployment of utility-scale renewable energy systems. However, as the California County Planning Directors Association (CCPDA) reports many local governments are resource constrained and face significant barriers to updating their regulatory frameworks to meet the rapidly changing clean energy market. [66]

As noted in a 2011 staff report exploring opportunities for renewable energy on state property, local governments do not determine permits for renewable energy facilities on state property, but state agencies often need to ensure projects are consistent with local requirements. Also, renewable energy projects on state property may include facilities located on private property that falls under local government jurisdiction for permitting.[67] The complexities of permitting

65 See Figure 43 on page 28 of the Annual Planning Survey: http://www.opr.ca.gov/docs/2012_APSR.pdf.

66 See slide 33 in the "2012 AEP Presentation on Streamlining Solar PV Strategies": http://www.ccpda.org/en/resources/docsandreports/cat_view/81-solar-issues?orderby=dmdate_published

67 Barker, Kevin, Jim Bartridge, Heather Raitt. 2011. *Developing Renewable Generation on State Property,* California Energy Commission. Publication number: CEC-150-2011-001.

renewable energy projects on state property can create an insurmountable barrier to the competitiveness of innovative strategies for renewable energy. Greater coordination among state agencies and local governments in IOU service territories can help overcome this barrier and allow IOU ratepayers to capture the benefits of locating renewable energy on state property.

Purpose: This initiative will upgrade city and county comprehensive plans, regulations, and codes to facilitate deployment of clean energy technologies and balance development impacts. By investing in comprehensive planning and appropriate permitting processes at the local level, the Energy Commission will further the goals of EPIC and continue to bridge a partnership between state and local governments.

The grant program will invest in the planning and permitting activities of local governments in IOU service territories in California, and will vary its roles in facilitating clean energy infrastructure based on the structure of local governments and local conditions across the state.

The Energy Commission will work closely with the Office of Planning and Research (OPR) to design applicant eligibility criteria and project eligibility criteria. The Energy Commission expects that eligible applicants will include all cities and counties within IOU service territories; however, proposals will not duplicate projects awarded funds pursuant to Public Resources Code Section 25619. To the extent practicable, the Energy Commission encourages neighboring cities and counties to submit regional consortium applications; however, the terms and agreements of grant applications will be made with individual cities and counties.

The Energy Commission will place an emphasis on awarding grant funds to grant proposals that address multiple technologies and leverage existing efforts like the CCPDA Model Solar PV Ordinance and OPR's Solar Permitting Guidebook. Also, the Energy Commission will consider grant proposals that provide regulatory assistance to coordinate permitting activities related to renewable energy projects on state lands.

The Energy Commission will ensure that EPIC investments are not duplicative of existing efforts, like the U.S. DOE SunShot Initiative, and other public investments to upgrade regulatory frameworks at the local government level. To maximize ratepayer return on investment, the Energy Commission will establish a preference for regional grant proposals that take advantage of economies of scale and create regional standardization.

Background: The state has taken little action to invest in upgrading local comprehensive plans that facilitate clean energy development. Regulatory assistance and permit streamlining is needed to ensure that local governments are prepared and informed on how best to facilitate market adoption of clean energy technologies.

Through their Planning Grants Program, the Strategic Growth Council (SGC) invests in local and regional comprehensive planning. The Planning Grants Program awards Proposition 84 funding on a competitive basis to cities, counties, and regional governments that propose

planning projects that will result in sustainable community plans and natural resource conservation. However, these projects do not usually focus on clean energy. Most of the funding for SGC's Planning Grants Program has been awarded.[68]

S14.3 Proposed Funding Initiative: Conduct a Local Government Needs Assessment Study that Identifies Regulatory Gaps Within Local Planning and Zoning Processes.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X		X	X	X	X	X	

Issue: To date there have only been a handful of efforts that attempt to understand planning and zoning gaps for renewable technologies at the local government level. These efforts have focused mostly on distributed solar PV, though local governments have authority over a wide range of clean energy technologies. As EPIC begins to invest in innovative strategies to streamline deployment of clean energy technologies the program administrators will need to collect updated local government planning and zoning information. This updated information will assist the program administrators with designing future EPIC investment initiatives as well as measure benefits to ensure the program administrators efficiently use EPIC ratepayer funds.

Purpose: This initiative will review existing planning and zoning documents to assess the current regulatory environment at the local government level and track changes in specific planning and zoning gaps that impede clean energy deployment. The Energy Commission will use findings to track EPIC investment performance and to inform and revise scope and eligibility criteria of future grants and award programs through EPIC. The Energy Commission and OPR will coordinate with state and local regulators to identify regulatory barriers that prevent or delay implementation of clean energy projects. The assessment will focus on local governments that are within IOU service territories.

This initiative will select an entity that can provide an assessment of the current planning and zoning policy environment governing clean energy technologies at the city and county level. The chosen entity will provide an assessment that identifies planning and zoning gaps for each clean energy technology in cities and counties that include IOU service territories. Identified gaps will serve as the basis for prioritizing public funds targeted to local government in future EPIC funding opportunities. On a regular basis, this work will update the analysis of planning and zoning gaps. This will contribute to an ongoing assessment of program performance and

68 For more information on SGC's Planning Grants Program: http://www.sgc.ca.gov/planning_grants.html.

benefits to ratepayers. This work will also generate independent recommendations on regulatory assistance program design and investment strategies.

Background: Energy Commission staff is aware of some efforts being taken to assess the clean energy regulatory environment. Current assessments are limited to distributed solar PV, and include:

- In May 2012, the California County Planning Directors Association (CCPDA) presented responses to the Energy Commission from a survey of 22 county planning directors.[69] Of the 22 responses, only one county has developed a renewable energy overlay zone, though most expressed a need to develop overlay zones. Over 98 percent of the responses expressed a need for public funds to complete overlay zones.
- OPR's 2012 annual planning survey (previously known as the Planners' Book of Lists) is an important assessment of local planning policy within California. In the last few years, OPR has included assessments of energy and clean energy planning at the local level, mostly related to distributed solar and wind energy. In 2012, OPR received responses from 87 percent of local governments and found that nearly 65 percent "of jurisdictions do not have policies, programs, or ordinances that facilitate the development of renewable energy facilities."
- U.S. DOE funds SolarTech's Solar 3.0 program, which is a process innovation initiative to standardize the regulatory environment of distributed solar PV to reduce non-hardware costs. Solar 3.0 ranks 753 cities across the United States according to their "solar market readiness." Solar 3.0's survey is voluntary and uses ranking criteria such as population, solar insolation, electricity prices and other economic indicators. To date, Solar 3.0 ranks 490 California cities, 79 of which are in the top 200 cities in the United States.[70]

An up-to-date assessment of all technologies in the EPIC clean energy value chain is needed to inform the Energy Commission of priority investment areas.[71]

69 http://energy.ca.gov/2012_energypolicy/documents/2012-05 10_workshop/presentations/Snellings_Tim_CCPDA_05-10-12.pdf

70 http://solar30.org/communities/baseline-comparison/

71 This issue was discussed during the Energy Commission's August 2-3, 2012, workshop in Sacramento, CA, and also in the August 9-10, 2012, workshop in Los Angeles, CA.

S14.4 Proposed Funding Initiative: Collaborate with Local Jurisdictions and Industry Stakeholders to Create Model Ordinances for Emerging Clean Energy Technologies

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X		X	X	X	X	X	X

Issue: As new clean energy technologies become commercially-viable, local governments will need to have ordinances in place that accommodate the incorporation of such technologies within their communities.

Purpose: This initiative will help local governments establish the appropriate ordinances in advance of new technologies becoming fully deployable in markets. These efforts will serve to mitigate any issues that may result from the delayed adoption of ordinances related to the planning and permitting of clean energy technologies.

Background: Commercialized technologies, like distributed solar PV are receiving investment to create best practices and model standards to regulate solar PV at the local level. In California, these investments include two collaborative stakeholder practices driven by the California County Planning Directors Association (CCPDA) and the Governor's Office of Planning and Research (OPR).[72] At the federal level, U.S. DOE sponsored the Solar America Board for Codes and Standards (Solar ABCs) to provide information to local permitting agencies on best practices for permitting small solar PV systems.[73]

The U.S. DOE is also challenging local agencies to improve solar PV permitting standards at regional scales by funding the Rooftop Solar Challenge.[74] Existing investments to develop resources for local governments regulating distributed solar PV are helping fully commercialize solar PV technologies and do not require further public investment in developing resources and information. However, local governments need additional information to help prepare the way for the portfolio of other clean energy technologies, including pre-commercial clean energy technologies moving through the technology innovation pipeline. For example, clean energy technologies like pre-commercial anaerobic digestion bioenergy and utility-scale non-thermal power systems will depend on local regulatory agencies for permitting.

72 CCPDA developed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres and less. http://www.ccpda.org/solar
OPR developed a permitting guide for small solar PV systems, adapting principles from the Solar ABC's with common interpretations of state code regulating small solar PV installations.
http://opr.ca.gov/docs/California_Solar_Permitting_Guidebook.pdf
73 http://www.solarabcs.org/
74 http://www.eere.energy.gov/solarchallenge/

Under this initiative, EPIC will identify best management practices from an environmental perspective for energy projects such as forest biomass harvesting.

S14.5 Proposed Funding Initiative: Provide Funding to Assist in the Development of the General Plan Guidelines.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X			**X**	**X**	**X**	**X**	

Issue: The regulatory environment governing clean energy development differs greatly across markets and develops at different paces across jurisdictions. Cities and counties are at the forefront of facilitating clean energy deployment, yet many cities and counties do not recognize clean energy technologies in their comprehensive plan. With varying and often absent development standards, developers and local governments are uncertain how to develop clean energy projects. Development uncertainty adds costs for developers and can increase development impacts on communities. Some clean energy investments provide resources to cities and counties to update comprehensive plans, help minimize development risks, and mitigate development impacts. However, cities and counties lack traditional and authoritative guidance for including clean energy in the comprehensive planning process.

Purpose: This initiative will develop planning frameworks for clean energy development by partnering with the Office of Planning and Research (OPR) to conduct a competitive solicitation for an awardee to assist in the development of the General Plan Guidelines focusing on projects that interconnect in IOU service territories. OPR will lead preparation of the next update of its General Plan Guidelines in 2013 (GPG 2013). The GPG 2013 updates current guidelines and will provide guidance for cities and counties for modernizing local government comprehensive plans, including guidance related to clean energy development.

This initiative will provide input for OPR's update of California's General Plan Guidelines. These guidelines serve as the foundation for city and county general plans. The Energy Commission will work closely with local governments and OPR to ensure a range of clean energy technologies are included in the GPG 2013 and to ensure the GPG 2013 will offer regulatory guidelines necessary to facilitate the development of clean energy technologies in all stages of the technology maturation curve.

Background: The current General Plan Guidelines need to be updated to reflect plans for significant deployment of clean energy technologies in IOU service territories.

Government Code Section 65040.2 directs OPR to adopt and periodically revise guidelines for the preparation and content of local general plans. The last update was in 2003. OPR is revising

the guidelines to include issues and guidance for renewable energy and other sustainable strategies related to energy. Cities and counties use the guidelines prepared by OPR to update their own comprehensive planning. OPR is also contemplating the development of a web-based tool to assist cities and counties with updating local comprehensive plans.[75]

In 2012, the California County Planning Directors Association (CCPDA) completed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres or less. While the CCPDA model ordinance provides the type of policy guidance that local governments depend on for clean energy, the ordinance only applies to solar PV generators that are roughly 7 megawatts or less. Advice for local governments in the General Plan Guidelines should include regulatory policies for all clean energy technologies. This initiative will provide planning information specific to projects interconnecting in IOU service territories.

S14.6 Proposed Funding Initiative: Develop Consensus Based Educational Materials for Local Officials Interested in Facilitating Clean Energy Market Growth.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X			**X**	**X**	**X**	**X**	

Issue: Through their land-use powers, local governments have regulatory authority over the development of most clean energy technologies. Most local governments in California are resource constrained and have little experience with planning for the land use impacts of new clean energy technologies emerging from the clean energy innovation pipeline. The lack of resources and knowledge at the local level can impede deployment of clean energy technologies in the latter stages of the technology maturation curve.

Purpose: Develop and disseminate clean energy planning and permitting information for local governments in IOU service territories by partnering with the Institute for Local Government (ILG) to hold a competitive solicitation to select an awardee to construct a suite of planning and permitting resources for projects interconnecting in IOU service territories. The resources will be promoted through ILG. For example, the resources developed by the awardee could be promoted through expanding ILG's Beacon Award to recognize local governments that display a commitment to fostering the deployment of clean energy technologies. [76]

75 http://opr.ca.gov/docs/GPG_2013_One_Pager.pdf

76 The Beacon Award: Local Leadership Toward Solving Climate Change, sponsored by the Institute for Local Government and the Statewide Energy Efficiency Collaborative, is a statewide program recognizing California cities and counties that are working to reduce greenhouse gas emissions, save

This initiative will complement ILG's ongoing efforts to provide local governments with information related to sustainable planning initiatives that require local government implementation.

Developing the clean energy informational resources will require participation from a wide variety of stakeholders, including but not limited to, local governments, state agencies, clean energy developers, and clean energy trade associations. Through a collaborative process, driven by ILG, the awardee will work with these stakeholders to develop planning and permitting resources for a portfolio of clean energy technologies, focusing on interconnection processes in IOU service territories. Once developed, ILG will use their existing outreach efforts to make this clean energy planning and permitting information available.

Information dissemination to local governments for the planning and permitting of clean energy technologies is important to ensure that clean energy technologies achieve market potential. Providing local governments with planning and permitting information, including best practices, related to pre-commercial clean energy technologies helps ensure that local governments can balance community impacts and clean energy deployment without placing over-burdensome regulations on the clean energy industry.

Background: Commercialized technologies, like distributed solar PV are receiving investment to create best practices and model standards to regulate solar PV at the local level. In California, these investments include two collaborative stakeholder practices driven by the California County Planning Directors Association (CCPDA) and the Governor's Office of Planning and Research (OPR).[77] At the federal level, U.S. DOE sponsored the Solar America Board for Codes and Standards (Solar ABCs) to provide information to local permitting agencies on best practices for permitting small solar PV systems.[78] The U.S. DOE is also challenging local agencies to improve solar PV permitting standards at regional scales by funding the Rooftop Solar Challenge.[79]

Existing investments to develop resources for local governments regulating distributed solar PV are helping to commercialize solar PV technologies and do not require further public

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energy and adopt policies and programs that promote sustainability. For more information see Beacon Award resources from ILG: http://www.ca-ilg.org/BeaconAward.

77 CCPDA developed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres and less. http://www.ccpda.org/solar.

OPR developed a permitting guide for small solar PV systems, adapting principles from the Solar ABC's with common interpretations of state code regulating small solar PV installations. http://opr.ca.gov/docs/California_Solar_Permitting_Guidebook.pdf.

78 http://www.solarabcs.org/ .

79 http://www.eere.energy.gov/solarchallenge/ .

investment in developing resources and information. However, local governments need additional information to help prepare the way for the portfolio of pre-commercial clean energy technologies moving through the technology innovation pipeline.

Developing and disseminating clean energy information related to local planning and zoning is part of the Energy Commission's larger strategy to invest EPIC funding on initiatives that help facilitate market growth of clean energy investments.

S15 Strategic Objective: Strengthen the Clean Energy Workforce by Creating Tools and Resources that Connect the Clean Energy Industry to the Labor Market

Table 16: Ratepayer Benefits Summary Table for Strategic Objective 15

	Promoter Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S15.1 Develop a Standardized Methodology to Assess Job Creation	X	X	X	X			X	X	X
S15.2 Provide Grants for the Development or Enhancement of Training and/or Apprenticeship Programs to Support Clean Energy Deployment Programs in IOU Service Territories	X	X	X	X			X	X	X

Developing a well-trained clean energy workforce will increase the quality of clean energy infrastructure. The clean energy industry currently lacks sufficient tools and resources to align workforce training with labor demand. EPIC addresses this issue by prioritizing activities to assist in bridging the gaps between job seekers and employers. These activities will include: a workforce needs assessment; a comprehensive statewide clearinghouse, which will address the needs of both the clean energy industry and workforce communities by providing updated information on training programs, job opportunities and research; and grants for the development or enhancement of training and apprenticeship programs.

S15.1 Proposed Funding Initiative: Develop a Standardized Methodology to Access Job Creation and Net Jobs

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
	X		**X**	**X**	**X**	**X**	**X**

Issue: Current workforce development programs have struggled to meet the challenge of finding employment for workers in the fast growing clean energy industry. Current data for job quality and access to jobs resulting from the state's clean energy policies and programs is limited, and is often years behind, which impedes the workforce development community. It is vital to have workforce data updated annually to determine which job skills are required, and which training programs to develop. Investment should be directed towards disadvantaged communities so that they may enjoy the environmental and job creation benefits.

Purpose: This initiative will collect accurate and comprehensive data to gauge the present state of the workforce, and to forecast needs for the future.[80] The Energy Commission will seek advice from workforce agencies, IOUs, employers, labor organizations, and academic institutions on the methodologies and tools required to collect the data.

This initiative will develop a report, that can be amended annually providing a "report card" to ensure that the benefits of workforce training and collaboration with employers has played a role in creating a new, healthy green workforce. Besides providing a high-level view of the current workforce, the report should also focus on the following:

- The impact of the current economy on rural and disadvantaged communities.
- The expiration of federal stimulus funding and how it affects community colleges, trade associations, and other training providers.
- The need to coordinate with veteran groups to encourage the training and hiring of veterans.
- The need for providing regulatory training to local government officials.
- Encouraging involvement of new technology stakeholders with the development of training curriculum, procedures and identifying experts.

80 This issue was discussed during the Energy Commission's August 2-3, 2012, workshop in Sacramento, CA, and also in the August 9-10, 2012, workshop in Los Angeles. The Energy Commission received written comments in support of this initiative on behalf of the following parties: Michele Rodriguez and UC-Berkeley Donald Vial Center on Employment in the Green Economy.

- The role of apprenticeships.
- The role of the California Conservation Corp and their services.
- Employers partnering with local colleges to develop training programs.
- Externships or sabbatical opportunities for instructors at the high school and junior high level to get teachers familiar with industry standards.

Background: There have been numerous studies conducted regarding the clean energy economy. The California Employment Development Department's, "Index to the Digest of Green Reports and Studies," fills 24 pages with a list of all the studies conducted throughout the United States. [81]

One study, "The California Workforce Education and Training Needs Assessment for Energy Efficiency, Distributed Generation, and Demand Response" which was prepared by researchers at the University of California, Berkeley's Donald Vial Center on Employment in the Green Economy, and funded by California utility ratepayers, under the auspices of the California Public Utilities Commission (CPUC), examined the following key areas:

- The impact of state and federal energy efficiency policies and programs on jobs and the labor market.
- The need to improve the quality of the installation of energy efficiency equipment and materials in some sectors by developing and supporting a stable and professionalized workforce.
- The need to coordinate and refocus the many pieces of the training system to incorporate new energy efficiency knowledge and skills, build on the strengths of state-certified apprenticeship programs, and build pipelines into good jobs for workers from disadvantaged communities. [82]

The study was mandated in the *California Long Term Energy Efficiency Strategic Plan* to provide recommendations to the CPUC and other agencies on the workforce strategies needed to achieve the state's ambitious energy efficiency goals.

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81 State of California, Employment Development Department labor market reports, "Index to the Digest of Green Reports and Studies" located at: http://www.labormarketinfo.edd.ca.gov/contentpub/GreenDigest/Green-Digest-Index.pdf.

82 Report prepared by the University of California, Berkeley's Donald Vial Center on Employment in the Green Economy, "California Workforce Education and Training Needs Assessment for Energy Efficiency, Distributed Generation, and Demand Response" located at: http://www.irle.berkeley.edu/vial/.

The Energy Commission received support for this initiative in comments received after the August 2012 EPIC Workshops. Also, the EPIC Staff Proposal, dated February 10, 2012, provides direction for this initiative by stating ratepayers "would benefit from a standardized approach to defining and tracking workforce development efforts". [83]

S15.2 Proposed Funding Initiative: Provide Grants for the Development or Enhancement of Training and/or Apprenticeship Programs to Support Clean Energy Deployment Programs in IOU Service Territories

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
	X			**X**	**X**	**X**	**X**

Issue: As the U.S. economy recovers, the housing market improves, and labor demand increases, the rapidly growing clean energy industry will expand. The presence of a quickly deployable and well-trained workforce will be instrumental in furthering California's clean energy goals. This initiative will help ensure that there is a continual feed into the clean energy workforce, with trained job seekers available to meet future labor demand.

Purpose: This initiative will provide grant funding for community colleges, universities, and/or third parties for developing new, or enhancing existing, clean energy training and apprenticeship programs for delivery to target communities in California's IOU territories. Such programs will focus on the design, development, sales, installation, and maintenance of clean energy technologies. The Energy Commission may consider programs with focuses outside of these areas, but still related to clean energy technologies, upon submission.

The Energy Commission intends to establish a working group to guide efforts in developing appropriate certifications for energy-related apprenticeships through collaboration with the Division of Apprenticeship Standards (via interagency agreement)[84]. Certifications will assist employers in easily identifying desirable skill sets for employees.

Several parties expressed general support for workforce development activities; some also identified specific target audiences for such efforts (for example veterans, students, and

83 California Public Utilities Commission, Proceeding R.11-10-003, EPIC Staff Proposal, Attachment A, February 10, 2012, located at: http://docs.cpuc.ca.gov/efile/RULC/159429.pdf.

84 The Energy Commission recognizes the importance of collaborating with other parties to ensure that apprenticeship certifications reflect industry needs. The working group should include representatives from groups such as the North American Board of Certified Energy Practitioners and the United States Department of Energy.

disadvantaged community members)[85]. The Energy Commission encourages grant applicants seeking to establish programs for targeted audiences to apply for funding.

This initiative will complement the EPIC-funded Clean Energy web portal initiative. Information about how to apply for EPIC training and apprenticeship grants will be available through the web portal. Information gathered through the job seeker and employer portions of the web portal will help in determining where funds are most needed, and thus may assist in the process of awarding funds.

Background: In recent years, the California Clean Energy Workforce Training Program, funded through the American Recovery and Reinvestment Act (ARRA), provided grants to community college districts, counties, and cities.

The Los Angeles Trade Technical College Clean Energy Pre-Apprenticeship (CEPA) Program is a partnership between Los Angeles area community colleges, Workforce Investment Boards, and employers. The Kern, Inyo, Mono Consortium Green Building Pre-Apprenticeship Program is a similar effort[86]. Other efforts to advance clean energy jobs may be in place. However, in the event that a grant applicant is requesting funds to enhance their current program, the applicant will be required to provide a detailed description of what the supplement funds will be used for, and how such additions will improve the program. This initiative will continue to fill a demand previously addressed by the California Clean Energy Workforce Training Program.

The training and apprenticeship programs will have significant local benefits, as employers will be able to use low- to zero-cost labor by helping develop the skills necessary for the future locally trained and available clean energy workforce. Utilities and ratepayers benefit with lower installation cost, and improved quality installations of efficiency and renewable equipment and services. Unemployed persons will be able to participate in the programs to broaden their skill sets, and improve their chances at finding work. By training more workers in targeted communities, this initiative will contribute to increased economic development as more workers enter the local labor force in a variety of clean energy industries.

85 The Energy Commission received written comments in support of workforce development efforts on the behalf of the following parties: Division of Apprenticeship Standards, UC Berkeley, Donald Vial Center on the Green Economy, La Cooperativa Campesina California, Department of Veteran Affairs, California Community Colleges Chancellor's Office, Larry McLaughlin of College of the Desert, California Conservation Corps, Taft College, California Construction Industry Labor Management Cooperation Trust, FORMA, Los Angeles California Conservation Corps, and Sacramento Regional Conservation Corps.

86 See http://www.energy.ca.gov/cleanenergyjobs/pre_LAtrade.html and http://www.energy.ca.gov/cleanenergyjobs/pre_kern.html for more information on the CEPA program and the Kern, Inyo, Mono Consortium Green Building Pre-Apprenticeship Program.

S16 Strategic Objective: Guide EPIC Investments Successfully Through the Clean Energy Technology Innovation Pipeline by Connecting All Stakeholder Groups Involved in the Development, Deployment, and Integration Stages

Table 17: Ratepayer Benefits Summary Table for Strategic Objective 16

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Resources Code 740.1	Public Resources Code Section 8360
S16.1 Create a Web Portal that Connects Innovators, Investors, Educators, Job Seekers, and Policy Makers to Facilitate Wide-Spread Adoption of New Clean Energy Technologies within Communities Statewide.	X	X	X	X	X		X	X	X
S16.2 Conduct Technology Forums to Connect Innovators of Clean Energy Technologies with Potential Investors, Customers, Job Seekers, and Policymakers	X	X	X	X	X	X	X	X	X
S16.3 Conduct Technology and Environmental Assessments to Track Progress in the Clean Energy Industry and Assist in Developing Roadmaps for Future EPIC Investments	X	X	X	X	X	X	X	X	X
S16.4 Conduct the California End-use Energy Consumption and Saturation Characterization Survey		X		X				X	X
S16.5 Market Analysis of Innovative Strategies to Facilitate Clean Energy Storage, Demand Response, Electric Vehicles, and Renewable Energy	X	X	X	X	X	X	X	X	X

EPIC should track progress in key aspects of the clean energy industry to ensure that investments and policies are in a position to promote the advancement of emerging technologies in the industry. This strategy broadly covers the program tracking and market research elements of the EPIC, while connecting all of the stakeholders involved at various points along the technology innovation pipeline.

By including these initiatives as a part of EPIC, ratepayers will benefit from a streamlined approach to integration of new clean energy technologies. This will ultimately be realized through decreased costs to consumers, improved energy infrastructure, and increased

deployment of clean energy technologies (which will in turn lower greenhouse gas emissions and bolster economic development). Tracking the progress of new products as they flow through the technology innovation pipeline will also assist the Energy Commission in working with local jurisdictions to project the timeline and resource need for developing ordinances catered to the upcoming technologies.

S16.1 Proposed Funding Initiative: Create a Web Portal That Connects Innovators, Investors, Educators, Job Seekers, and Policy Makers to Facilitate Wide Spread Adoption of New Clean Energy Technologies Within Communities Statewide.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand –side Management
X	X	X	X	X	X	X	

Issue: Currently, there are no existing efforts that provide an across-the-board approach to guiding emerging clean energy technologies through the innovation pipeline and into full commercialization. The web portal will strengthen the clean energy industry by bringing together emerging technology innovators, educators, policy makers, local governments, jurisdictions, and the workforce to engage and align their programs, policies and practices[87].

The web portal will contain information that will make it possible to monitor industry progress, paying particular attention to workforce needs, policy structure, and financing/investment opportunities. Information gathered through this web portal will inform the Energy Commission of arising opportunities for new strategies or investments to consider in its EPIC Investment Plans for subsequent years.

Purpose: The objective of the web portal is to build on the successful partnerships the Energy Commission has developed with other California state agencies, IOUs, renewable energy associations, building trade unions, community colleges, state universities, workforce development providers, regulators, clean energy industry, and local governments to ensure that industry needs are met.

87 This issue was discussed during the Energy Commission's August 2-3, 2012, workshop in Sacramento, CA, and in the August 9-10, 2012, workshop in Los Angeles. Many panelists and stakeholders participating in these workshops expressed interest in using EPIC funds to develop a workforce clearinghouse. Energy Commission staff have expanded this concept to incorporate several other elements of the EPIC that were discussed during the workshops and/or in written comments.

Staff intends for this web portal to include information relating to the following areas:

- **Workforce Development and Education**: A repository on clean energy technology training programs, apprenticeship programs, best practices and models for clean energy training programs, and course syllabi and curricula.
- **Clean Energy Jobs**: This section of the portal would allow employers the capability to post information about their company, including job openings.
- **Market Research**: Compile and disseminate updated research from varied sources.
- **Communication**: Contain a social media function to engage industry stakeholders and interested parties.
- **Information Dissemination:** Provide information specific to innovators, investors, and local governments that would assist in further developing emerging technologies. Some examples include:
    - For innovators:
        - Warranty development – assisting small companies with developing appropriate warranties
        - Certifications – education and outreach on required/suggested certifications or safety listings for particular technologies
        - Provide small businesses information on intellectual property and how to protect their innovations
        - List of showcase sites: Provide a listing of potential demonstration sites to connect innovators with potential host sites
        - List of innovation clusters to connect innovators with others in their region
        - List of investors participating in clean energy space that may be interested in funding new technologies
    - For Investors:
        - List of businesses looking for venture capital investments (include business name and clean energy technology)
        - Information on emerging clean technology breakthroughs/new products developed
        - List of research grants
    - For Local Government:

- Model ordinances and permitting guides
- Opportunities for available funding

- **Emerging Technology Tracker**: Allow stakeholders the ability to track the progress of emerging clean energy technologies via a searchable database of EPIC projects. This will help agencies and researchers avoid duplication of activities and allows them to tap into on-going efforts, rather than wait for project conclusions and final reports. This will also assist local governments and jurisdictions with developing appropriate ordinances in advance of new technologies becoming fully deployable in markets. In addition, this will assist educators with developing new curriculum to prepare the workforce for new opportunities. Finally, monitoring the status and progress of the industry will enable the Energy Commission to continually improve the effectiveness of EPIC programs and projects.

Background: Commercialized technologies, like distributed solar PV are receiving investment to create best practices and model standards to regulate solar PV at the local level. In California, these investments include two collaborative stakeholder practices driven by the California County Planning Directors Association (CCPDA) and the Governor's Office of Planning and Research (OPR).[88] At the federal level, U.S. DOE sponsored the Solar America Board for Codes and Standards (Solar ABCs) to provide information to local permitting agencies on best practices for permitting small solar PV systems.[89] The U.S. DOE is also challenging local agencies to improve solar PV permitting standards at regional scales by funding the Rooftop Solar Challenge.[90] Existing investments to develop resources for local governments regulating distributed solar PV are helping fully commercialize solar PV technologies and do not require further public investment in developing resources and information. However, local governments need additional information to help prepare the way for the portfolio of pre-commercial clean energy technologies moving through the technology innovation pipeline. For example, clean energy technologies like pre-commercial anaerobic digestion bioenergy and utility-scale non-thermal power systems will depend on local regulatory agencies for permitting. As a result of these emerging technologies, the skill set needed for those in the clean energy workforce is evolving.

88 CCPDA developed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres and less. http://www.ccpda.org/solar. OPR developed a permitting guide for small solar PV systems, adapting principles from the Solar ABC's with common interpretations of state code regulating small solar PV installations. http://opr.ca.gov/docs/California_Solar_Permitting_Guidebook.pdf.
89 http://www.solarabcs.org/.
90 http://www.eere.energy.gov/solarchallenge/.

There are also policy drivers behind developing a clean energy workforce which include the Governor's Clean Energy Jobs Plan[91] and the goal for installing 12,000 MW of distributed generation (DG) by 2020, and 8,000 MW of large scale solar thermal along with energy efficiency technology investments, could potentially create thousands green jobs. This ambitious goal will not only stimulate the clean energy technology industry, but could potentially create significant economic growth in California.

Most recently the largest state-sponsored green jobs training program in the nation, the Clean Energy Workforce Training Program (CEWTP), provided millions of dollars to support workforce training programs at community colleges, workforce investment boards and partnership academies in high schools throughout California. The CEWTP was designed to target unemployed workers, especially those from the construction sector, low wage-workers and those preparing to enter the workforce for jobs in energy efficiency, water efficiency, renewable energy and clean transportation. The program was funded through a combination of money from the federal American Recovery and Reinvestment Act, public-private partnerships, and state and local programs. During the development of the CEWTP, and throughout the grant process, the Energy Commission created partnerships with numerous workforce entities. These partnerships are still in place and will provide a benefit as we move forward with this initiative.

S16.2 Proposed Funding Initiative: Conduct Technology Forums to Connect Innovators of Clean Energy Technologies with Potential Investors, Customers, Job Seekers, and Policymakers

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X	**X**	**X**	**X**		**X**		**X**

Issue: Without coordination across clean energy stakeholder groups, new technologies face significant barriers at several steps on the path to market entry and full commercialization. Innovators must find customers to purchase their product, investors who can provide funds to scale-up production to a commercial level, employees, and policymakers to support the technology and work to create accommodating laws and ordinances to facilitate integration of the technology on the local, state, and federal levels.

Purpose: Conducting technology forums encourages communication between the various stakeholder groups involved with the deployment and commercialization of new clean energy technologies and strategies will help innovators cross the technological and commercialization

91 See Governor Edmund G. Brown, Jobs for California's Future at: http://www.jerrybrown.org/jobs-california%E2%80%99s-future.

"valleys of death". Forums provide innovators with the valuable face-to-face networking opportunity with other stakeholder groups. These forums will also function as a means for disseminating information and status updates about various EPIC projects to the public.

Background: The interaction between stakeholder groups is vital to understanding all of the elements related to increasing the presence of clean energy technologies. Current process silos each of the elements into its own section, and few opportunities for collaboration exist. Dates of the forums will be available on the Clean Energy web portal, and distributed to the Energy Commission and EPIC listserves. As suggested by stakeholders, the Energy Commission will work with other parties to plan the forums so that different stakeholder groups can host and lead the discussions, selecting relevant topics. Forums will take place periodically throughout the state, and will feature varying discussion topics related to the clean energy industry.

S16.3 Proposed Funding Initiative: Conduct Technology and Environmental Assessments to Track Progress in the Clean Energy Industry and Assist in Developing Roadmaps for Future EPIC Investments

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X	X	X	X	X	X	

Issue: Roadmaps are necessary to identify the status of technologies and the need for future EPIC fund investment in the electricity sectors in California as they relate to Applied R&D, Technology Demonstration and Deployment and/or Market Facilitation.

To create roadmaps, the Energy Commission should conduct technology and environmental assessments to determine the status and costs of various clean energy technologies. Such assessments will help the Energy Commission identify any unforeseen barriers or environmental issues related to the deployment of new products. Market research on energy-related environmental impacts and mitigation can help fill critical data gaps that hinder environmental siting and mitigation, thereby reducing risk and uncertainty in the permitting process, and assisting with regulatory streamlining efforts.

Purpose: By tracking the progress of emerging clean energy technologies and identifying potential environmental effects of emerging clean energy innovations, the Energy Commission will be better positioned to facilitate successful IOU market deployment of technologies. Moreover, the CPUC EPIC Decision clearly identifies the need for metrics to evaluate the effectiveness of EPIC programs and projects; conducting technology status and cost assessments in addition to environmental assessments will help the Energy Commission measure the success of EPIC-funded projects by providing a basis for measuring improvement and growth within the industries. Information gathered through this process will inform the Energy

Commission of opportunities for new strategies or investments to consider in EPIC Investment Plans for subsequent years. Bringing Energy Commission staff and external stakeholders together in the roadmap development process minimizes duplicative investments, encourages innovation, and yields outcomes that are more likely to successfully address the challenges of funding multiple research areas.[92]

Background: The U.S. DOE's Energy Efficiency and Renewable Energy department issues annual market reports for solar, wind, and fuel cell technologies.[93] This initiative would establish similar tracking reports for new technologies and technologies that have yet to reach full commercialization, but should not duplicate existing efforts for commercialized technologies. Reports produced through this initiative would be available via the Clean Energy web portal.

S16.4 Proposed Funding Initiative: Conduct the California End-use Energy Consumption and Saturation Characterization Survey

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
			X	X	X	X	X

Issue: California's detailed end-use energy consumption and saturation data is outdated and inhibits development of reasonable and defensible energy demand forecasts, negatively influences CPUC long term procurement planning (LTPP) activities, obscures understanding of baseline California energy consumption, prevents strategic development and evaluation of efficiency programs, prevents quantification of efficiency and demand response reductions and policies, inhibits assessment of shifting demand growth impacts on transmission, and prevents regular energy demand trend measurements. And, most significantly in the EPIC context, it hampers solid and defensible information on the current end-use baseline, from which progress will be measured.

92 This issue was discussed during the Energy Commission's August 2-3, 2012, workshop in Sacramento, CA, and also in the August 9-10, 2012, workshop in Los Angeles. Panelists and stakeholders participating in these workshops were supportive of efforts to assess the current energy markets for various technologies. The Energy Commission also received written comments in support of similar activities from the following parties: UCLA; Michele Rodriguez; CCSE; Kristin Skierka of Energy Initiatives; California Wind Energy Association; Terra Gen Operating Company; Audubon California; and the Lawrence Berkeley National Laboratory.

93 http://www.eere.energy.gov/topics/renewable_energy.html

Purpose: The collection of detailed end-use data not only helps in development of standards, but it more importantly is used in evaluating how effective those standards have been in changing consumption patterns and lowering amounts of energy used. End-use surveys tell us who, when, where, why and how much California's residents, businesses, and industries use energy. There is no other substitute for gathering this information. End-use values are used to develop detailed demand energy demand forecasts, efficiency market potential studies, to efficiently develop focused energy related policies, and to aid in the development of standards.

The California Public Utilities Commission uses California Energy Commission statewide demand forecasts in their LTPP activities. LTPP sets procurement directions for utilities and the forecast helps them set the amounts of various kinds of resources needed in keeping with the loading order; cost recovery and rates are set in General Rate Cases. Potential studies support the strategic development of efficiency programs. A representative characterization of end-uses facilitates monitoring, and development of metrics for monitoring of, EPIC funded performance activities through appropriate benchmarking. The California Independent System Operator (California ISO) supports transparent and adequate metrics conforming to the utility value chain model predicated upon detailed knowledge of energy consumption, technology adoption, and market potentials. California utilities' require this information for forecasting and planning activities.

Title 20 data collection requirements state surveys for residential, commercial, and industrial sectors are to be performed every four years. Surveys are designed to fully characterize residential, commercial, and industrial sectors. Over the past two decades, surveys have been performed sporadically due to resource and participation constraints. However, in 2009 the Energy Commission funded a residential survey to capture end-use appliance saturations and energy consumption. The last commercial end-use survey performed was completed in 2006. Given significant changes in the market, the Energy Commission is currently exploring opportunities to fund a commercial survey in the near future.

Background: Prior surveys, successfully managed by Energy Commission staff, have led to important and widely referenced sources of data. Unfortunately, these surveys have not been regularly implemented due to the lack of funding. Historically these surveys were funded through CPUC energy efficiency funds. The Energy Commission was able to partially fund some survey activities through a Budget Change Proposal with contract funding, but this annual appropriation was removed in 2010-2011 given current resource constraints and budgetary issues.

CPUC evaluation measurement and verification (EM&V) program collects data but emphasizes specific technologies and is not intended to represent California energy demand. Consequently, the CPUC data collected does not provide the detail needed for forecasting. Additionally, CPUC funded activities typically do not include publicly owned utilities (POU) which need to be captured within any statewide survey. In the past, the Energy Commission or the publicly owned utilities have provided additional funding to collect data from their service territories.

Energy Commission staff will either obtain additional funding for the POU territories or only survey the IOU territories.

These surveys will focus on appropriately characterizing markets, providing baseline energy usage data, and providing baseline technology saturation data. The intent of the survey is to characterize the most important Californian end-uses in enough detail to allow forecasting, policy effectiveness evaluation, and policy development.

Recent discussions with CPUC EM&V regarding funding have been unsuccessful because priorities for current two-year funding cycle are already defined; the CPUC is conducting market tracking studies that are valuable for efficiency program development purposes, but not forecasting. The potential exists for the CPUC to fund end-use survey activities in the future.

End-use surveys and the associated analytical work performed in the past continue to provide benefits to ratepayers by providing important data to ongoing analyses. Energy Commission staff continue to respond to data requests and provide data in published reports which are utilized for energy efficiency potential studies, end-use demand analyses, and energy policy development. One important function of the end-use data is to develop demand forecasts for the CPUC's LTPP activities. This ensures only needed resources are procured thereby directly benefiting ratepayers. The Energy Commission's ability to analyze and forecast energy demand is an essential element of Energy Commission energy-monitoring functions. These monitoring functions serve as an early-warning system on whether trends are consistent with State policies, helping policy-makers to maintain the long-term functioning and stability of the market. Data on energy consumption, load research and end-user characteristics are the building blocks of the Energy Commission's ability to provide this service.

Public Utilities Code Section 8360 sets out the state's policy to support the development of a smart grid. End-use survey and saturation study activities further smart grid development by providing data and analyses useful for strategic deployment of appliances and technologies. The survey activity will also aid with the identification of current appliance distributions and help identify where opportunities exist for further action. In addition to market opportunities, a statewide end-use demand and saturation characterization would assist with identification of barriers and issues with technology and service deployment within California.

S16.5 Proposed Funding Initiative: Market Analysis of Innovative Strategies to Facilitate Clean Energy Storage, Demand Response, Electric Vehicles, and Renewable Energy

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
			X	X	X	X	X

Issue: The California ISO, CPUC, and IOUs are in the process of identifying new tariffs, innovative strategies, and market design changes to advance the state's goals for clean energy, including strategies for clean energy storage,[94] demand response,[95] and electric vehicles-to-grid implementation.[96] These strategies are intended to help integrate high penetrations of renewable energy generation into California's electricity system.[97] Market analysis and behavioral research is needed to inform development of proposed strategies and identify gaps that could be addressed through additional innovative strategies for clean energy, or even more fundamental market design changes.[98]

Purpose: This funding initiative will provide competitive solicitations for clean energy market analysis. The purpose of the market analyses is to help identify and respond to gaps in assessments of the ratepayer price, cost, and impact of new tariffs and strategies to facilitate clean energy storage, demand response, and renewable energy. The Energy Commission will work closely with the California ISO, CPUC, and IOUs to develop the scope for each competitive solicitation and identify the pathway for results to inform the development and deployment of new tariffs, innovative clean energy strategies, and market design changes.

Background: In the past, the Energy Commission has conducted market analysis and behavioral research to inform development of tariffs and strategies to advance the utilization of demand response in California's electricity system. Similar analysis for tariffs and strategies is currently under consideration.

In addition, analysis is needed to identify whether changing market conditions are creating a need to revise tariffs and market design elements to better capture emerging opportunities to facilitate clean energy strategies.

94 For more information on the CPUC's energy storage proceeding: http://www.cpuc.ca.gov/PUC/energy/electric/storage.htm

95For more information on the California ISO's demand response initiative: http://www.caiso.com/1893/1893e350393b0.html

96For more information on CPUC activities related to electric vehicle charging infrastructure: http://www.cpuc.ca.gov/PUC/hottopics/1Energy/090814_ev.htm

97For more information on recent activities related to renewable integration: http://www.energy.ca.gov/2012_energypolicy/documents/2012-04-12_workshop/comments/PGE_Comments_on_Evaluating_and_Capturing_the_Benefits_of_Renewable_Energy_for_California_2012-04-20_TN-64860.pdf

98 The Energy Commission received written comments in support of similar activities from the following parties: UC Davis, A Better Place, Coulumb Technologies, California ISO, CALSTART, and Grant Management Associates.

CHAPTER 6: New Solar Homes Partnership

The New Solar Homes Partnership (NSHP) follows the state's "loading order" which identifies an order for guiding energy decisions: electricity needs should first be addressed by increased energy efficiency and demand response, second by renewable resources, and third by clean fossil fuel generation. The NSHP requires that all projects exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 15 percent. This decreases the customer's electricity demand and ensures properly sized systems. By encouraging the installation of residential solar systems, NSHP also supports the goals of SB 626 (Chapter 355, Statutes of 2009), Assembly Bill 32, and Executive Order S-3-05. SB 626 seeks to overcome barriers to the deployment and use of plug-in hybrid and electric vehicles. Although the peak for solar generation does not occur at night, which is when a plug-in vehicle is most likely to be charged, due to the net metering arrangements a customer can still use the solar energy system to offset the cost of charging a vehicle. Assembly Bill 32 and Executive Order S-3-05 seek to reduce GHG emissions.

Proposed Budget Allocation

The CPUC EPIC Phase 2 Decision addresses funding for the NSHP. The decision references the February 10, 2012 CPUC staff proposal and states "Commission staff estimate that prior annual PGC collections were approximately $146 million, with an additional approximately $40 million per year or more being authorized in various proceedings allowing utility cost recovery for RD&D projects. $162 million, plus an anticipated approximately $25 million for the NSHP program, achieves the same approximate total as in the past. Should the Legislature not authorize additional EPIC funding for NSHP, the Commission may choose to reevaluate whether to increase the EPIC total budget, and for what purposes, in the future."[99] The Energy Commission supports an increase to the EPIC total budget to provide up to $25 million annually to fund NSHP, with up to ten percent of this total for administration. Such an increase would raise the EPIC total budget, consistent with the combined level of funding provided through the PGC collections and the utilities' cost recovery RD&D projects prior to EPIC.

Funds are currently scheduled to be repaid to the Renewable Resource Trust Fund (RRTF) over the next two years for use on the NSHP. These funds amount to approximately $95 million, with the majority due to be repaid by June 30, 2013. Assuming these loans are repaid, no EPIC funds will be needed for the NSHP for several years. Funding for NSHP should be collected at a level of up to $25 million per year in the event repayments are not made to the RRTF. If EPIC funds are not needed for the NSHP in any given year, collections in future years for NSHP

99 Phase 2 Decision, p. 87.

could be reduced or eliminated. This level of NSHP funding is consistent with the recommendations in the Phase 2 Decision.[100] The Energy Commission annual EPIC reporting to the CPUC will include the level of total funds for the NSHP and balance of funds available for reservations; based on the annual update on NSHP, further adjustments in the EPIC funding can be made to ensure total funding for NSHP does not exceed $400 million.

Policy Justification

The Phase 2 Decision recommended continued funding for the NSHP, but stated that NSHP could not be funded through EPIC without affecting the total SB1 California Solar Initiative (CSI) funding cap under Public Utilities Code Section 2851 (e). The Decision agreed with continuing NSHP "...as a matter of policy, because it is a vital piece of the CSI program targeting builders of new homes." (p. 54) The Decision also stated that NSHP supports the "…goal of construction of all zero net energy new homes in California by 2020" as identified in the 2008 California Long Term Energy Efficiency Strategic Plan. (p. 56) The Decision urged the Legislature to amend existing law to either increase the total CSI funding cap or modify the funding source for the NSHP to allow the CPUC to fund the NSHP without reducing the budget for the CSI program. At the end of June 2012, the law was amended for this purpose by SB 1018 (Statutes of 2012, Chapter 39, Section 111), which modifies Public Utilities Code Section 2851 (e) and permits EPIC moneys to be used to fund the NSHP without affecting the total CSI funding cap.

The Energy Commission supports increasing the EPIC total budget to provide up to $25 million annually to fund NSHP. Since 2007, the NSHP has issued incentive reservations at an average rate of $24.8 million per year. In 2011, incentive reservations totaling $32 million were issued, and nearly $40 million in reservations has been issued so far in 2012. As of September 2012, there is roughly $10 million available for NSHP incentive reservations.

During the Energy Commission's EPIC workshop on August 2, 2012, the California Building Industry Association (CBIA) provided comments that the remaining NSHP funds are likely to be claimed quickly. CBIA indicated that many large new homebuilders are considering including "solar as a standard" in their new developments, but these plans are contingent on NSHP funding availability. A summary of stakeholder comments and responses will be included in the appendix.

The NSHP provides a one-time, upfront incentive for eligible projects. The incentive is an Expected Performance-Based Incentive (EPBI) that encourages quality installation of solar energy systems. There are two incentive structures, one for market rate housing and affordable housing common areas, and another for affordable housing residential projects. The market rate housing incentive structure is further broken down into two incentive levels: Tier 1 and Tier 2.

100 See Phase 2 Decision, p. 57.

The Tier 1 incentive is for buildings that exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 15 percent. The Tier 2 incentive is for buildings that exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 30 percent. The current incentives level for Tier 1 and Tier 2 market rate housing are $2.00 and $2.25 per watt respectively. The incentive level for affordable housing residential units is $2.90 per watt. The incentive levels are scheduled to drop as specified capacity target are reached. Additional detail on the incentive levels and their decline schedule can be found in Chapter 3 of the *New Solar Homes Partnership Guidebook*[101].

To be eligible for NSHP, the applicant must be an electric customer of PG&E, SCE, SDG&E, or Bear Valley Electric Service. The solar energy system must use new equipment, and major system components must be listed on the SB1 Eligible Equipment Lists.[102] The solar energy system must serve new residential construction projects. The buildings in the project must exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 15 percent. These eligibility criteria are described in Chapter 2 of the *New Solar Homes Partnership Guidebook*.

To prevent overpayment of funds and discourage oversized systems, the NSHP has funding limitations. Program incentives are limited to the first 7.5 kW of a system for residential units. In addition to the system size cap, affordable housing residential unit incentives are limited to no more than 75 percent of the total system cost and market-rate housing incentives are limited to no more than 50 percent of the total system cost. Applicants may not receive incentives from both the NSHP and another CSI program. If the applicant receives an incentive from another incentive program that is not part of CSI, then a minimum of 5 percent of that amount will be subtracted from the NSHP incentive amount. (*New Solar Homes Partnership Guidebook*)

The *New Solar Homes Partnership Guidebook* lists additional eligibility criteria relating to energy efficiency, building foundation, transient housing, system equipment and installation, and lease and power purchase agreements. Staff recommends keeping the program eligibility criteria and requirements as described in the NSHP Guidebook. The NSHP was designed with input from an advisory committee consisting of key stakeholders, and the program Guidebook has evolved over the past 5 years based on stakeholder feedback received at staff workshops. Stakeholders are now familiar with the program requirements and processes. To remove the NSHP Guidebook and begin the development of new program rules halfway through the program would create stakeholder frustration and discourage program participation.

The NSHP provides many ratepayer and societal benefits. The NSHP supports self-generation of electricity, which reduces demand for electricity from the utility. Much of the demand

101 http://www.energy.ca.gov/renewables/06-NSHP-1/documents/index.html

102 http://www.gosolarcalifornia.ca.gov/links/equipment_links.php

reduction occurs during hours of peak demand. This benefits ratepayers in a number of ways. The reduced demand on the electric grid decreases the need for the Investor Owned Utilities (IOUs) to purchase electricity from non-renewable sources. This lowers overall costs to ratepayers by reducing the need for additional infrastructure to be built and helps the utilities avoid the higher generation costs from entering into costly contracts for reserve electricity supplies. This also reduces the greenhouse gas emissions that would be generated from non-renewable sources.

Additional environmental and safety benefits come from an increased grid stability, which reduces the potential for power outages that could affect critical health or emergency services.

The NSHP incentive reduces the system cost, thereby reducing the payback period and offering the customer an affordable alternative to reducing their electric bills. In addition, the NSHP helps spur investment in solar energy in California, which provides economic benefits: according to a 2009 report by the Center for American Progress (*The Economic Benefits of Investing in Clean Energy*), for every $1 Million spent on solar, 9.8 direct and indirect jobs are created.

The effectiveness of the NSHP can be evaluated not just by the number of installations funded but by the economic and environmental benefits it promotes. By requiring eligible projects be highly energy efficient new construction, applicants can incorporate solar energy systems into their home design before the home is built. This allows any locational constraints to be addressed prior to the solar energy system installation, allowing for a properly sized system, and reducing overall project costs. NSHP also removes the financing barriers that often prevent homeowners and builders from installing solar energy systems on their home and in their developments. Builders receiving NSHP incentives for a development are often able to take advantage of economies of scale further driving down the final cost to the homeowner.

Energy Commission staff is working on the development of an online tool called PV Check. This program would allow customers to track the daily output of their solar energy system, and make sure that their system is working as expected. The NSHP will use this information to help fulfill auditing requirements. Another Energy Commission online tool already in use is the Solar Advantage Value Estimator (SAVE) calculator. The target audience is contractors, realtors, appraisers, and lenders, and the SAVE calculator educates them on the potential value of a solar energy system by calculating the added value of a solar energy system for a new or existing building.

The U.S. DOE's Sunshot Initiative aims to decrease the total costs of solar energy systems. A decrease in total system costs will remove some of the financial barriers that potential applicants face, increasing program participation. With expected decreasing system costs and increased program participation from the programs mentioned above, NSHP will take steps to ensure that the provided incentives do not exceed the total system costs.

NSHP currently collects information on equipment costs, installation costs, and permitting costs. Much of the data collected to date is shared with various research groups and is available to the public through the NSHP online application tool. This information can be used to monitor trends in system costs and help identify the distinct cost components that may be preventing total system prices from decreasing. This information can also be used by Energy Commission staff in coordination with data from other programs such as the CSI's average system cost caps to develop strategies to ensure that the NSHP incentive levels are set appropriately.

The NSHP's energy efficiency requirements complement the energy efficiency requirements of the IOUs' California Advanced Homes Programs, which offer energy efficiency incentives for new residential construction. The synergy between the two programs allows for some streamlining in the NSHP, reducing administrative costs.

PUC Section 740.1 identifies the following principles to be used in evaluating programs: provides reasonable probability of providing benefits to ratepayers, consistent with the resource plan, non-duplicative of other efforts, support environmental improvement, public and employee safety, conservation by efficient resource use or reducing or shifting system load, development of new resources and processes, and improve operating efficiency and reliability. PUC Section 8360 seeks to modernize the state's electrical transmission and distribution system to maintain safe, reliable, efficient, and secure electrical service.

The NSHP program addresses the principles of PUC Section 740.1 and Section 8360 by providing market support and promoting the purchase and installation of solar energy systems, encouraging the development and improvement of new and existing solar technologies. The NSHP is the only program in IOU service territories that provides incentives for installing solar photovoltaic systems on new residential construction. The incentives do not cover the full system costs, maximizing the use of ratepayer funds and ensuring that funds are spent efficiently. The incentive offsets solar energy system costs, making solar energy systems cost-competitive with conventional forms of electricity and affordable for more consumers. Because much of the electricity produced from a solar energy system occurs during peak demand hours, the demand for electricity in IOU service territories is reduced. This reduces the potential for power outages during periods of peak demand.

Funding for the NSHP through PGC collections is continuously appropriated, allowing funds released from prior incentive reservation to be utilized for new applications, regardless of the amount of time that elapsed. However, EPIC-funded NSHP projects will be limited to a 1-year encumbrance period and a two-year liquidation period unless the legislature takes action to provide a longer or continuous appropriation period. This means that the maximum reservation period for incentives under the NSHP will need to be shortened from 3 years to two years or less. In addition, funds released from a prior incentive reservation will not be returned for use by the NSHP unless re-authorized by the Legislature.

The Energy Commission currently has about $10 million in funds for the NSHP. Based on historical activity and industry comments, these funds are expected to be reserved in the near future. The Energy Commission strongly supports the collection of additional funds though EPIC to support the NSHP. However, because no funds are currently being collected for the NSHP and the CPUC is not scheduled to adopt the EPIC investment plans until May 2013, it may be necessary for the CPUC to expedite the collection of these additional EPIC funds, if so approved, to ensure the NSHP is not adversely affected by a funding gap.

CHAPTER 7: Program Administration

This chapter discusses the procedures and processes the Energy Commission will follow for selecting and funding projects and programs, managing the funded projects and programs, and conducting program outreach efforts. The chapter starts with a discussion of how stakeholders can participate then continues with a discussion of how projects will be selected and awarded. The award process covers the types of funding mechanisms that will be used, eligibility criteria, and funding limitations. The project management section discusses oversight and monitoring of funded projects to ensure they meet their stated objectives. The chapter concludes with an overview of outreach strategies that will be used to disseminate results and the Energy Commission's approach to intellectual property within the EPIC program framework.

Stakeholder Participation and Annual Reporting Requirements

Stakeholder Engagement

The Energy Commission will consult with stakeholders, in a public forum, at least twice each year to provide program updates and gain valuable insight on progress and direction. Such outreach will provide transparency and accountability for investments, coordinate research to avoid duplication, seek opportunities to leverage funds, and ensure research is targeting ratepayer benefits. During these meetings, members of the public will be invited to participate; however, the Energy Commission will target, at a minimum, the following stakeholders:

- Members of the Legislature, to the extent their participation is not incompatible with their legislative positions
- Government, including state and local agency representatives
- Utilities
- Investors in energy technologies
- California Independent System Operator
- Consumer Groups
- Environmental organizations
- Agricultural organizations
- Academics
- Business community
- Energy efficiency community
- Clean energy industry and/or associations
- Other industry associations

The Energy Commission held its first stakeholder workshops on August 2-3, 2012 in Northern California and on August 9-10, 2012 in Southern California. The purpose of the workshops was

to gain stakeholder input prior to the development of this Investment Plan. Public comments received as a result of the workshops will be summarized in the appendix. A third workshop will be held on September 27, 2012 to provide an overview and solicit public comment on the Investment Plan.

The Energy Commission is considering creating advisory groups to inform the implementation of the investment plan, to avoid duplicating existing research, development and deployment activities, and to facilitate a faster and more effective sharing of program results. The Energy Commission welcomes comments on this proposal.

Annual Reporting

The Energy Commission will submit annual reports to the CPUC by February of each year, beginning in 2014. As articulated in the CPUC Phase II decision, annual reports will provide a program status update, including all successful and unsuccessful applications for EPIC funding awarded during the previous year.

An independent, third party, evaluation of the EPIC program overseen by the CPUC will be conducted at the completion of each triennial term. The purpose of this evaluation is to assess the effectiveness of the program and provide recommendations for program improvement.

Competitive Award Preference for EPIC Funds

The vast majority of initiatives included in this investment plan will be implemented through the Energy Commission's competitive solicitation process to ensure a fair, open, and transparent opportunity for interested parties. The Energy Commission preference for a competitive selection process in EPIC will apply to public and private entities. The procedures for competitive solicitations will follow applicable requirements from the State Contracting Manual, State Public Contracts Code, Public Resources Code, and other laws and regulations, such as civil service restrictions, prevailing wages, and the California Environmental Quality Act.

Prior to releasing a solicitation, staff will identify the specific research, demonstration or deployment objectives for the solicitation. Solicitation objectives will be designed to remove specific clean energy deployment barriers and will be mapped to achievement of specific clean energy goals. These objectives are typically derived from a roadmap or through stakeholder workshops. Roadmaps are documents prepared for specific program areas that identify high priority research initiatives needed to meet state policy, industry and private sector goals.

Administrative Cost Containment

The Energy Commission will monitor its administrative costs to manage the EPIC program within the 10 percent cap established in the Decision. Administrative cost will also be part of the

competitive project selection process, as is discussed later in this section. The Energy Commission established an electronic template that EPIC applicants will complete that calculates administrative costs in a comparable manner.

Foster Investments in California

The EPIC investments will maximize funds spent in California to foster and grow California businesses and institutions. This will have direct and indirect economic benefits here in the state. This is further discussed in the project selection criteria section.

Coordination with other Research, Demonstration and Deployment Efforts

The Energy Commission will stay abreast of research, demonstration and deployment activities both in-state and nationally. Agencies with energy related activities such as United States Department of Energy; United States Department of Defense; CPUC and the ARB will provide key input into the EPIC gap analysis and road mapping activities. In the past, The Energy Commission staff have participated in U.S. DOE's research planning activities; project scoring and/or program evaluation. This is an invaluable tool for both avoiding duplication and leveraging related activities. The U.S. DOE and California energy-related agencies (CPUC, ARB, California ISO, Energy Commission) have initiated a high level dialog to facilitate improved collaboration.

California's national labs and academic institutions are leaders in clean energy research innovations and the Energy Commission will encourage broad participation from across the state in EPIC implementation.

The Energy Commission is committed to on-going collaboration with the three utility administrators. Coordination meetings have been valuable in the development of this investment plan to identify each administrator's area of focus, as well as suggest synergistic opportunities to collaborate on projects. On-going collaboration will be a cornerstone of the program to assure EPIC activities bring the highest benefit back to the ratepayers that pay for the investments.

Competitive Solicitation Process

The solicitation process begins with posting a funding opportunity announcement on the Energy Commission's website that contains all the information needed by interested parties to participate in the solicitation. The Energy Commission will notify interested parties via a number of available list servers of the funding opportunity.[103] All funding opportunity

[103] To register for the EPIC List Serve: http://www.energy.ca.gov/research/epic/

announcements will indicate the topic or topics addressed in the solicitation, the funding available, and project and applicant eligibility.

The posted opportunity notices on the Energy Commission website will contain all the materials, including electronic files, needed for a successful submission. These documents will include the application manual, required templates, and all instructions. The application manual identifies the solicitation purpose and objectives, the funding levels for research topics, project and applicant eligibility requirements, screening and/or scoring criteria, match funding requirements, selection and award process, grounds for submittal rejection and the solicitation schedule. There are templates for preparing work statements and budgets. Also included are the state's terms and conditions that each applicant must agree to comply with. A sample solicitation is included in the appendix.

Shortly after a solicitation has been posted on the web, Energy Commission staff will hold a publically noticed workshop to review the solicitation purpose, requirements, eligibility, and research topics with interested parties. The public workshop provides an opportunity for potential applicants to ask questions on the solicitation and the application process. There is also an opportunity for interested parties to submit written questions about the solicitation. The staff's responses to questions will be posted on the Energy Commission website to ensure that all potential applicants have access to the same information. Any revisions, corrections, and clarifications on the solicitation will also be posted on the Energy Commission website.

Project Award Requirements in the Three Funding Areas

The CPUC EPIC decision outlined three funding areas for the Energy Commission administered programs: Applied Research and Development, Technology Demonstration and Deployment, and Market Facilitation. Additionally, a set aside of $XX is planned to provide match funding to California applicants that are successful in obtaining Federal grants from the U.S. Department of Energy and other federal agencies. The purpose is to help California companies and research entities secure federal funds that will benefit California ratepayers and the economy. This will be discussed further in a later section of this report.

Applied Research and Development Award Requirements

Projects in the applied research and development investment area will focus on new technologies, methods, and approaches from early bench-scale up to pilot-scale prototype demonstrations that seek to solve identified problems in the electricity system "value chain". Non-technology approaches are also included, such as strategies and methods to enhance adoption of clean energy technologies, R&D that addresses electricity-related environmental and public health impacts, clean energy transportation, and building and appliance codes and standards. Funded work in this area will provide help removing barriers and advancing state energy goals for renewable energy, energy efficiency, smart grid, and electric transportation.

Applied research and development efforts evaluate the technical feasibility and practicality of proposed solutions, strategies or technologies. At this phase in the innovation pipeline, projects awarded funding will not have a clear business case for deployment of private capital, meaning that the amount of match funding in most cases will be low, if any. Therefore, match funding is typically not required for research projects in this program area. However, bidders that provide match funding can receive higher scores during the proposal evaluation process. There is an overall program goal of meeting 20 percent match funding in this applied research and development area.

The following table provides a summary of the three-year funding for applied research and development, the estimated project award per recipient, match fund requirement and amount of funding set aside to match federal grants. Each solicitation would have project minimum and maximums, along with match requirements, tailored to the individual solicitation.

Table 18: Summary of Three Year Funding for Applied Research and Development

3-Year Funding for Applied Research and Development	$158.7 million
Estimated Minimum/Maximum Project Award Per Recipient	$250,000 to $3 million*
Match Funding Requirement	None but those providing match will receive higher scores during proposal evaluation
Estimated Funding to Match Federal program investments (3 years)	$XX million**

* Individual projects vary due to broad spectrum of projects under applied research from a simple component project to a pilot scale test. Pilots will generally not exceed $3 million of EPIC funds though we retain the option for larger pilot-scale demonstrations with higher matching funds.
**Set aside funding to leverage federal program investments to promote federal economic investments in California.

Technology Demonstration and Deployment Award Requirements

Projects under the technology demonstration and deployment (TD&D) investment area will focus on technologies, methods, and approaches that are beyond the "proof-of-concept" stage. These projects must have completed field, lab, bench-scale and/or pilot-scale work with verified performance data to warrant pre-commercial/commercial scale-up.

The overall goal for projects funded under the EPIC TD&D is to demonstrate innovative technologies at an appropriate scale, at an appropriate host-site (demonstrated in the intended market of the technology), under "real-world" conditions and to validate energy, water and cost savings, air quality and electric transportation sector improvements, overall economics (including operational and maintenance costs), reliability, life-cycle cost assessment, and other criterions necessary to commercialize the technology/strategy and gain public acceptance. EPIC

TD&D projects will be expected to have a clearly articulated path to market and that will be an important scoping criterion.

When appropriate, the EPIC program will strive to coordinate with the investor-owned utilities to provide research results and technologies that can be incorporated into utility sponsored incentive/rebate programs to accelerate wider market adoption and deployment. Additionally, there may be opportunities to collaborate on projects to maximize the synergistic effect of both utility and Energy Commission EPIC programs. The EPIC program will also strive to partner with private companies such as industrial, agriculture, renewable energy sectors, automotive manufacturers, residential and commercial building industries, and entrepreneurs in clean energy markets to advance demonstration and deployment projects and programs. Projects awarded should demonstrate a clear link to business and commercialization with a plan to manufacture and market successful technologies within 5 years after successful demonstration.

Since TD&D projects have higher levels of private benefits and are near to commercialization, match funding will be required for all TD&D projects. At a minimum, 20 percent of requested EPIC funds must be pledged as match funds. The solicitation application manual may require contingency plans to replace lost match funds, or specify stricter requirements on the level of matching funds and define what may be counted as matching funds.

The Energy Commission's three year funding amount for TD&D is $129.9 million. Of this amount, 20 percent or about $26 million will be set aside for bioenergy, as indicated in the CPUC EPIC decision.

The following table summarizes the three year funding for Technology Demonstration and Deployment for Research Demonstrations, excluding the set aside for bioenergy. Each solicitation would have project minimum and maximums, along with match requirements, tailored to the individual solicitation.

Table 19: Summary of Three Year Funding for Technology Demonstration and Deployment

3-Year Funding for Technology Demonstration and Deployment	Up to $129.8 million
Estimated Minimum/Maximum Project Award Per Recipient	$1 million to $5 million*
Match Funding Requirement	20percent of the requested EPIC funds. Those providing match funds in excess of 20 percent will receive higher scores during proposal evaluation
Estimated Funding to Match Federal program investments (3 years)	$XX million**

* The Energy Commission reserves the right to release technology demonstration and deployments with a minimum award less than $1 million if deemed necessary for advancing clean energy technologies or strategies.

**Set aside funding to leverage federal program investments to promote continued national economic investments in California.

Market Facilitation Award Requirements

Projects under the market facilitation (MF) investment area will address funding gaps in market processes and includes a wide range of activities including:

- Program tracking
- Market research
- Education and outreach
- Regulatory assistance/streamlining
- Workforce development or support clean energy technology deployment

The overall goal is to help ensure that products or strategies make it all the way through the technology development cycle and are delivering benefits to consumers.

Market facilitation efforts support clean energy technology and strategy deployment. Though they can lead to more widespread application of technologies and strategies, there is not a clear business case for deployment of private capital, meaning that the amount of match funding in most cases will be low, if any. Match funding is typically not required for projects in this program area; however, bidders that provide match funding can receive higher scores during the proposal evaluation process. The following table provides a summary of the three-year funding for market facilitation, the estimated project award per recipient and match fund requirement.

Table 20: Summary of Three Year Funding for Market Facilitation

3-Year Funding for Market Facilitation	$43.3 million
Estimated Minimum/Maximum Project Award Per Recipient	$25,000 to $3 million
Match Funding Requirement	None. Those providing match funds will receive higher scores during proposal evaluation

Match Funds for Federal Awards

A portion of EPIC funds will be set aside to leverage federal funds and boost research investments and economic benefits to California. The following criteria will be used to evaluate potential requests to provide cost share to match federal funds from the U.S. Department of Energy (U.S. DOE) and others:

- The research projects goals/objectives are aligned with those in this investment plan
- The potential recipient is a California based applicants
- The EPIC funds will be spent in California to benefit electric ratepayers
- The potential recipient receives a federal award

This will be similar to the pilot the Energy Commission did with American Recovery and Reinvestment Act funding. Under the American Recovery and Reinvestment Act of 2009, the Energy Commission successfully leveraged more than $500 million in federal stimulus funding while providing $21 million in match funding for projects that are consistent with the Energy Commission's research program and state's policy goals. Depending on the research goals and work scope, the EPIC funds to match the federal grant may come from Applied Research and Development or the Technology Demonstration and Deployment (TDD) funding areas as indicated in separate Research Initiatives. EPIC match funds will be capped at X percent of the federal award. It is anticipated that the selection and evaluation of proposed bidders requesting EPIC funds to match federal awards will be through a competitive process similar to that described in this investment plan but emphasizing the criteria described in this section. Refer to initiative S10.3

Integrating Source(s) of Funding in a Solicitation

The typical solicitation will be EPIC funding only. However, the Energy Commission recommends allowing a combination of funding sources in the same solicitation, when it adds value to the ratepayers by doing so. For example, some barriers and solutions may benefit from an electricity and natural gas integrated approach and it would therefore be beneficial to include EPIC funding and natural gas funding in a few solicitations. The reason is that some initiatives (for example, HVAC or building envelope) can have both electric and natural gas savings and having a joint solicitation captures the synergy associated with both fuel savings. Any such use of multiple funding sources will be clearly identified in the funding opportunity notice and all proposals will be required to demonstrate how the proposed project will provide benefits to both electric and natural gas ratepayers.

As an example, one of the proposed initiatives in this plan is to develop, test and demonstrate advanced building envelope systems, materials and components to improve building efficiency. This initiative could result in technologies that could affect both air conditioning and heating in buildings. As most buildings in California use electricity for air conditioning and natural gas for heating, this research could result in envelope systems that could reduce both energy sources. Thus, the project could be funded with both EPIC and natural gas funds. Gas and electric funds, as well as benefits, would be tracked and reported separately.

Bidder Eligibility

EPIC solicitations will be open to all public and private entities and individuals interested in electricity related applied research, technology demonstration and market facilitation. Eligibility for receiving EPIC funding through the competitive process are based upon the specific screening and scoring criteria set forth in the solicitation application manual as explained in the following sections.

Proposal Scoring

Each proposal submitted in response to an EPIC solicitation will be screened and scored according to criteria as prescribed in the application manual. A sample scoring criteria will be shown in the appendix. Typical scoring criteria can include an assessment of the strength of the team, technical and economic validity of approach, and an evaluation of benefits to California ratepayers.

Proposal scores will be based upon a series of technical criteria to ensure that the proposed project has merit and is feasible, does not duplicate another efforts, the team is qualified and the budget reasonable. At a minimum, proposals must be organized in a way that facilitates scoring of the proposal, such as:

- Incorporating the scoring criteria within the proposal project narrative,
- Discussing the project in sufficient detail,
- Identifying and quantifying rate-payer benefits from the project with clear justification on all assumptions,
- Discussing the projects market connection and the market size,
- Identifying and discussing the match funding and the source,
- Outlining project risks and measures to mitigate risk,
- Discussing project team qualifications and structure,
- Providing a detailed project scope of work, budget and schedule, and
- Discussing private partnerships and plans for technology transfer.

After the scoring is completed, a Notice of Proposed Awards (NOPA) will be released by the Energy Commission, identifying recipients for which EPIC funding is proposed. For each recipient receiving funding, a grant agreement or contract is developed and will be approved by the Energy Commission. For recipients not awarded funding, there will be a specified debriefing process as described in each solicitation.

Other Solicitation Criteria

California Based Businesses, Suppliers and Jobs

The Energy Commission under the EPIC program will strive to maximize research funds spent in California by providing scoring criteria in proposals that clearly illustrate the most direct economic benefits to ratepayers. This includes prime contractors and subcontractors including researchers, manufactures, suppliers, and other labor forces with headquarters and employees that are located in California. Proposals with fewer funds and direct benefits going to California ratepayers will receive lower scores.

Loaded Rates

Another area of emphasis in EPIC solicitations will be ensuring reasonable overhead and general administrative costs. As organizations use different accounting practices to account for direct labor, overhead and general and administrative costs, the Energy Commission's program and contract staff have determined that an effective way to evaluate costs is to calculate loaded rates. Loaded rates include direct labor, fringe benefits, overhead, general and administrative costs, and profit. Each proposal will be evaluated based on its "average weighted loaded rates" for the entire research team. This rate is determined by considering the researchers loaded rates and anticipated hours during the course of the project. Lower average rates will result in higher scores.

Contracting

The Energy Commission uses either grant agreements or contracts to establish agreements with recipients receiving funding under the EPIC Program. Both grants and contracts identify the task requirements, schedule and budget for the funded effort.

The mechanism for awarding most contracts or grants will be a competitive process. Non-competitive awards may be granted in selective circumstances as discussed in a later section.

Agreement Terms and Conditions

Each solicitation will identify the terms and conditions to be used in the solicitation. These can be private entities, private universities, non-profit organizations, the University of California (UC), California State University Foundations, the U.S. Department of Energy National Laboratories and others. All recipients must agree to the terms and conditions prior to entering into an agreement.

Each grant agreement or contract includes terms and conditions which set forth the recipient's rights and responsibilities. When the funding recipient is the UC or a U.S. Department of Energy National Laboratory, the terms and conditions will be those that have been specifically negotiated by the Energy Commission or the Department of General Services for these agencies.

Research Centers (UC and National Labs)

Under EPIC, The Energy Commission plans to establish a competitive process for investments in research centers. The Energy Commission previously funded research centers via Interagency Agreements to target research on technologies and analyses most needed to advance evolving energy policies, on public interest research not addressed elsewhere, and as a cost-beneficial method to bring together researchers, industry, manufacturing and policy experts, universities and national labs. Centers have been very effective at moving innovative technologies into products that become supported by California markets or advancing science to serve as decision support for policy makers. Additionally, centers located at universities provided an opportunity to be a teaching laboratory for students to prepare the workforce of today and tomorrow. Many of the Centers leveraged state funding and secured private and federal funding.

An example of a research center funded with RD&D funds is the California Lighting Technology Center (CLTC). The CLTC at the University of California, Davis, stimulates, facilitates and accelerates the development and commercialization of energy efficient lighting technologies. The CLTC's research is strongly connected with private industry, state regulatory agencies and utility emerging technology programs. This research has resulted in technology advancements and has informed the state's building energy efficiency standards, resulting in savings to Californians of an estimated 167 million kilowatt-hours (kWh) annually. This translates to annual savings of $25 million to Californians and a reduction of over 138 million pounds in greenhouse gas emissions. These energy savings are due to a successful business model implemented at the CLTC. This model is built on a "lab to marketplace" strategy that includes research to develop energy efficient lighting technologies, activities to overcome market barriers for new technologies, addressing and supporting regulatory processes, and training to realize large scale deployment of energy efficient lighting technologies and best practices. This model has facilitated the market adoption of over 20 energy-efficient lighting technologies that are now commercially available and sold by multiple manufacturers. The Energy Commission has invested around $8 million in state research funds, which has accounted for about half of CLTC's funding. This state funding leveraged additional funding from industry, utilities, academia and others. The impacts of the program far outweighed the costs. Every state dollar invested in CLTC has resulted in over $3 dollars in electricity cost savings.

There is significant ratepayer value in the research products, workforce training, and leveraging public funds provided by research centers. Under EPIC the Energy Commission will pursue opportunities to advance these highly cost-effective technological and analytical innovative incubators. However, research centers will be required to compete for funding. Solicitations will be developed to provide multi-year funding for research centers that meet a specific set of criteria depending on the outcomes targeted. Some examples of criteria that could be included in a solicitation are:

- Unique research that addresses a major energy using/technological area with fast changing and evolving technology.
- Proven track record of providing explicit electric ratepayer benefits. This can include developing technologies and strategies that have had an impact on reducing energy costs, improving public health, increasing energy reliability, creating jobs and other benefits to California ratepayers.
- Successfully using state research funds to leverage other private and public funding, such as from industry, manufacturers, utilities and the U.S. Department of Energy. The desire is not to have EPIC funds be the only source for the center.
- Strong private, industrial, manufacturing and utility partnerships with demonstrated need for goods and services
- Demonstrated successful "path to market", such as market penetration of goods and services or significant analyses that inform policy. One of the best ways to ensure that the products and services developed are needed and will be used is to ensure that there is a partner who will use the results. This will help ensure that the resulting research will not languish in the Valleys of Death but will actually be used or commercialized.

Non-Competitive Awards

Non-competitive awards could occur with public agencies and with private entities. For public agencies, the State Contracting Manual allows contracts directly with UC, California State University, National Laboratories and other public agencies without competition.[104] As a result, the Energy Commission anticipates a few circumstances where interagency agreements or sole-sources will be justified, and cannot be specified at this time. For example, a follow-on agreement to a successful project may not be conducive to a competitive process. Another example would be an interagency agreement with another state agency to implement a specific program or project, or match funding to a federal grant as stated earlier in the chapter under Match Funds for Federal Awards.

Project Management

A project agreement establishes a business relationship between the Energy Commission project manager and the recipient of EPIC funds. The EPIC project management process will include a number of checkpoints for reviewing the ongoing progress of the project. Standard template language for all contracts and grants will require awardees to participate in kick-off meetings to

104 State Contracting Manual, Chapter 3, Sections 3.03 and 3.06, http://www.dgs.ca.gov/ols/Resources/StateContractManual.aspx

establish deliverable expectations, roles and responsibilities, accounting procedures, and reporting requirements; monthly or quarterly progress reports to ensure the contractor is complying with the task schedules and specified in the contractual agreement; regular critical project reviews to monitor progress and make any necessary corrections to ensure project success; and final documentation in the form, for example, of data, engineering plans, final construction and operation of facilities, or final reports documenting research results and other contractual deliverables.

Energy Commission Project Manager

Each project funded will be assigned a single Energy Commission project manager. The project manager will be responsible for coordinating with funding recipients, providing project oversight and serve as the Energy Commission's point of contact for stakeholders interested in receiving more information about the project.

Critical Project Reviews

Research agreements will typically include critical project reviews at pre-designated milestones where the Energy Commission agreement manager will review the progress to date and decides whether sufficient progress has been made to warrant proceeding to the next project phase. This is an important management tool for research projects that do not always meet their initial goals, and decisions need to be made whether to terminate a project or to rescope the project based on research findings.

Technical Advisory Committee and Project Advisory Committee

EPIC research projects will typically include technical or project advisory committees (TAC or PAC). These committees will be composed of diverse professionals and can provide valuable perspective as the project matures. The number and composition of the committee members can vary depending on potential interest and time availability. The committee members serve at the discretion of the Commission Project Manager.

The committee may be composed of qualified professionals in the following disciplines:

- Researchers knowledgeable about the project subject matter
- Members of the trades who will apply the results of the project (for example, designers, engineers, architects, contractors, and trade representatives)
- Public Interest Market Transformation Implementers
- Product Developers relevant to project subject matter
- U.S. Department of Energy, academia and other governmental research managers
- Public Interest Environmental Groups

- Utility Representatives
- Members of the relevant technical society committees

The purpose of the advisory committee will be to:

- Provide guidance in research direction. The guidance may include reviewing scope of research, research methodologies; timing; coordination with other research to maximize synergy and avoid duplication. The guidance may be based on:
    - Technical area expertise
    - Knowledge of market applications
    - Linkages between the agreement work and other past, present or future research (both public and private sectors) they are aware of in a particular area.
- Review deliverables. Provide specific suggestions and recommendations for needed adjustments, refinements, or enhancement of the deliverables.
- Review and evaluate tangible benefits to California of this research and provide recommendations, as needed.
- Provide recommendations regarding information dissemination, market pathways or commercialization strategies relevant to the research products.

Outreach

The Energy Commission will conduct a number of activities to ensure that information regarding EPIC-funded projects and activities are available to stakeholders. The Energy Commission will employ a variety of vehicles to disseminate information tailored to the audience. The predominant media vehicles are described below. The Energy Commission will use professional industry networks and forums to share project highlights and significant findings. Technical Advisory Committees and Project Advisory Committees will provide recommendations for information dissemination and technical transfer priorities that are specific to each project and their industry. The Energy Commission will use these expert recommendations to maximize the strategic and meaningful distribution of project findings.

Scientific Journals and Trade Publications

EPIC projects that are of interest to the scientific community will be featured in scientific journals or trade publications. While these feature articles are not guaranteed, the Energy Commission will seek opportunities to highlight EPIC-funded projects to drive industry forward and extend the reach of research and development efforts. These articles will provide more depth and project detail than the fact sheets and describe the project's influence on policy development or industry momentum.

Project Fact Sheets

The Energy Commission will develop Fact Sheets for each project funded through EPIC. Fact Sheets will be posted on the Energy Commission website and will provide the public, stakeholders and decision-makers with current information on projects funded through EPIC. It can take several years, from the time a project starts to the conclusion of the project. The Fact Sheet, a one to two page summary, allows for an expedited means of keeping all interested parties informed. For longer-term projects or those that are of particular interest to the general public or industry stakeholders, the Energy Commission will publish revised fact sheets that include interim and final research findings. For non-research projects, like local government planning and permitting and workforce development activities, project fact sheets will describe project outcomes and identify lessons learned as well as best practices.

Reports

Projects funded through EPIC will include a final report that is technical in nature and thoroughly describes the issue or problem addressed by the research, the approach and analysis, findings, and recommendations for follow on activities. In some of the longer-term or high profile projects, interim reports will be required to capture analysis and results to-date.

Energy Commission staff will also produce annual reports for EPIC activities that include high-level summaries and anticipated electric ratepayer benefits for projects funded in that year.

Brochures

The Energy Commission will develop brochures and pamphlets to provide overviews of the core research, development and demonstration work pursued under EPIC. Previously developed brochures ranged in topics and depth, from the broad spectrum of Energy Commission R&D to more focused brochures on energy efficiency and renewable energy. The brochures will summarize the key research issues and gaps, barriers, challenges, and Energy Commission efforts to address these; and feature projects that resulted in successes.

The brochures will be used for legislative briefings, technical forums, and a variety of other venues to disseminate information, facilitate transparency, and share successes in the research efforts and outcomes that help shape California's energy future.

Energy Commission Website

Project fact sheets, final reports, and other documents related to or supported by EPIC funds will be accessible on the Energy Commission website to maximize transparency, and increase value, for the program and its projects. The Energy Commission website will also serve as a resource for Energy Commission proceedings related to the development of the triennial EPIC investment plan. On the website, interested stakeholders can navigate to EPIC policy documents, past workshop presentations, funding solicitations, annual EPIC reports, and other resources that provide a basis for active participation in the program. In the future, there are

plans to develop a searchable database for all EPIC funded projects. The EPIC website is: http://www.energy.ca.gov/research/epic/

Intellectual Property

Intellectual property (IP) refers to products of the mind that the law protects, such as copyrights, trademarks, and patents. The treatment of IP rights under a research, development, and demonstration (RD&D) program will impact its success. Correctly handling IP rights encourages participants in RD&D programs and advances the commercialization of new technologies. Incorrectly handling IP can have the opposite, negative impact on an RD&D program. To ensure EPIC is successful in this regard, IP rights under EPIC RD&D should advance the following three goals:

1. Provide tangible benefits to the ratepayers who pay for the RD&D;
2. Foster and not hinder the commercialization of new technologies, including advances in existing technologies; and
3. Advance the collective knowledge of energy RD&D.

One of the basic benchmarks of any RD&D program is whether it results in new, commercially successful technology. IP rights play a significant role in commercialization. For example, IP rights that inappropriately share ownership or make proprietary information public would prevent the commercialization of new technologies. An entity would no longer have a competitive advantage, and thus impetus, for developing new technology. Instead, IP rights must create the framework leading to commercialization.

Although it is important that IP rights lead to the commercialization of new technologies, IP rights must also allow the sharing of new scientific knowledge. Contributing to the world's scientific knowledge allows further advances to occur. It is also prevents duplication of efforts by others, which preserves RD&D funds for new efforts.

IP Rights under EPIC

To achieve the three goals in Section I, the IP rights under EPIC will be structured as follows:

1. Each EPIC RD&D project needs to identify:
    a. The IP that it will create in the form of new technology, advances in existing technology, or advances in scientific knowledge, and
    b. How the new IP will benefit the contributing ratepayers.
2. In general, the rights of IP developed under EPIC should be held by the entity developing it. Such entities are usually in the best position to commercialize the new

technology, and it is not the state's role to create programs that compete with private companies. However, the State may retain a license to use the intellectual property to protect ratepayer benefits.

3. The EPIC Program should have march-in rights to take IP that entities who accept EPIC funds develop but do not utilize. This will protect the ratepayers' investment in the IP and ensure that the benefits from the developed IP are received.

4. IP derived from general energy research that is geared towards new knowledge rather than product development should be put in the public domain, made publically available, or if kept by the entity, utilized such that the results are made public (for example, the University of California or national labs might keep the copyright to research papers, but then publish the results to make them known and available). This advances science and prevents other entities from performing duplicative research.

5. Royalties will not be collected unless statutory changes are made to allow it. The Energy Commission collects royalties under its Public Interest Research Program (PIER) because of the authority granted by Public Resources Code Section 25620.4. This authority is specific to PIER. The Energy Commission does not currently have the legal authority to collect royalties under EPIC.

CHAPTER 8: Program Benefits Assessment

Assessment Process

The CPUC Phase 2 decision requires that the Energy Commission include metrics against which the investment plan's success should be judged, including at least the following:

- Potential energy and cost savings;
- Job creation;
- Economic benefits;
- Environmental benefits;
- Identification of barriers or issues resolved that prevented widespread deployment of technology or strategy;
- Effectiveness of information dissemination;
- Adoption of technology, strategy, and research data by others;
- Funding support from other entities for EPIC-funded research on technologies or strategies; and
- Other benefits.

The Energy Commission will select from above the applicable benefits that will be measured based on the type of project, the energy use sector, type of technology, project funded and its stage in the energy innovation pipeline.

Program/Project Benefits Assessment

The Energy Commission will use a program-wide approach to benefits assessment, which will include integrating benefit and cost assessment elements into solicitation planning, implementation and project evaluation. The Energy Commission will implement prospective and retrospective benefits assessment. Prospective assessments are integral to the planning and project assessment process, estimating potential benefits based on size of the sector, magnitude of the barrier and solutions that are targeted. Retrospective assessments will be conducted in project closeout to capture actual achieved benefits. More specifically, the Energy Commission will integrate benefits assessment into the following program phases:

- Solicitation Planning
- Solicitation and Agreement Development
- Project Management
- Project Closeout

More details of the benefits assessment activities in each program phase are described below.

Solicitation Planning

In the solicitation-planning phase, the Energy Commission will define the problem and solutions targeted for each competitive solicitation. Solicitations will identify specific potential benefits and explicit targets within a particular energy use sector. Potential benefits evaluation will be part of the selection criteria. The following quantitative and qualitative benefits are the metrics against which a bidder's potential success may be measured:

Quantitative Benefits

- Potential energy and cost savings
- Job creation and net jobs
- Economic benefits
- Funding support from other entities (for example, match)
- Adoption of technology, strategy, and research data by others
- Other benefits

Qualitative Benefits

- Effectiveness of information dissemination
- Environmental benefits
- Identification of barriers or issues resolved that prevented widespread deployment of technology or strategy
- Enhanced grid performance in terms of reliability, safety and security
- Meeting and informing policy goals (i.e., RPS, AB 32, Loading Order, others)
- Public health and safety
- Other benefits

Solicitation/Agreement Development

Solicitations instructions will require bidders to provide data supporting potential benefits (i.e., quantitative and qualitative benefits) and information on the location of the research or project and the geography of the expected benefits. The Energy Commission will hold a pre-bidder's conference as part of the solicitation workshop to define the benefits assessment questions and to respond to bidders' question.

Where applicable, the bidder will be required to submit a proposal that includes an estimate of the potential benefits of the research if adopted by the market in terms of energy savings and cost savings. The bidder will also be required to present the basis or assumptions of the energy or cost savings calculations, including projections of the market penetration of the technology and the size of the market. Furthermore, a bidder will be required to submit a scope of work that specifies the method(s) to assess benefits and a description of how the bidder will disseminate the benefits information and the path to market for a technology. In the case of environmental or market research, bidders will typically provide qualitative prospective

benefits evaluations, which explain the need for the research, including which policy and regulatory drivers they are complying with and how the research will fill knowledge gaps or facilitate adoption of clean energy technologies.

To provide the attribution of benefits to EPIC funding–specifically public funding from EPIC rather than private sector funding–a bidder must discuss why the desired research or project outcome would not occur without EPIC funding or why it might not occur as quickly or in a manner beneficial to California ratepayers without EPIC funding.

The Energy Commission will evaluate and score potential awards based on a bidder's reasonable probability of achieving California ratepayer benefits; among other factors such as match/leveraged funds, research or market facilitation activities conducted in California, administrative/financial capability, and so on.

In the agreement development phase, the Energy Commission will incorporate in the proposed scope of work, the benefits to be measured. Where applicable, the agreement will include some or all of the following information to measure benefits during the project management and closeout phases:

- Quantitative and qualitative benefits
- Methods to measure benefits
- Issues or barriers to be resolved
- Test results
- Critical project review (see chapter 7)
- Specific deliverables to document the benefits
    - Fact sheets
    - Project Interim reports
    - Sharing technology information via workshops/conferences
    - Project Final reports
    - Post-program follow-up data sharing
    - Other information

Project Management

The Energy Commission will hire and retain staff with the applicable engineering, scientific and related skill set to effectively manage technical energy projects. During the project management phase, the Energy Commission will use its knowledge and experience from other Energy Commission programs to manage EPIC program agreements. This phase will begin with the assignment of the project to an agreement manager that will be responsible for overseeing the project. The Energy Commission will hold a kickoff meeting to reinforce the contractor's responsibility to measure benefits and communicate that to the Energy Commission. The agreement manager will visit the site, review all reports and be in regular communication with

the contractor to actively follow and shape the project to a successful conclusion. The Energy Commission will work closely with the researcher or award recipient to verify and capture, where applicable, potential benefits. The Energy Commission will also work with the researcher or award recipient to prepare a fact sheet that identifies the energy issue(s)/barriers that are preventing deployment, the planned research or investment initiative and the potential benefits for information sharing with the public through the Energy Commission's website.

Energy Commission staff will oversee projects and evaluate benefit assessments, as needed, through regular communications, critical project review meetings, monthly or quarterly reports, and final reports. In cases where the contractors are not meeting the projected benefits, the Energy Commission will advise on an appropriate course of action. The agreement manager will draw on internal and external experts to review project results during critical phases. Through the life of the agreement, the Energy Commission will work with the researcher or award recipient to assess and report benefits through project interim reports and stakeholder workshops or conferences. Finally, the Energy Commission will work with the researcher or award recipient to publish a final project report that includes the research and/or project results, including the quantitative/qualitative benefits, methods used to measure the benefits and the issues/barriers resolved.

Achieving benefits will be aided by consultation with other industry and agency experts. As the Energy Commission continues to administer the EPIC Program, it will consult with interested stakeholders to vet research initiatives and market facilitation activities and seek feedback to ensure that the research and activities continue to provide clear electricity ratepayer benefits.

Project Closeout

During the project closeout phase, the Energy Commission will capture achieved research results, along with the targeted market potential.

For a portion of projects, the Energy Commission will conduct in-depth post-project benefits assessment audits. Due to resource constraints, the Energy Commission will not do detailed analysis on all of the EPIC funded projects, but rather we will strategically focus on a sample of closed projects that merit consideration for follow-up interviews to determine represented quantitative and qualitative benefits. Additionally, the Energy Commission will validate the researcher's or award recipient's method(s) to measure benefits. The Energy Commission will share the benefits information in published project fact sheets, project final reports, annual reports to the CPUC and through other avenues such as published technology brochures and trade journals.

Standard Practices

In all cases, the Energy Commission will document the steps of benefits assessment and transparently present the uncertainties in the benefits calculations. Additionally, peer review of benefits calculations will also be a central practice in the Energy Commission's benefits assessment. Moreover, the Energy Commission will evaluate the EPIC program benefits

assessment processes by working with other benefits assessment practitioners, including government and other research organizations, to continually evaluate and improve the EPIC program benefits assessment process.

Next Steps

Through public workshops held in August 2012 and September 2012, the Energy Commission is gaining valuable stakeholder input for its first triennial Investment Plan. Public comments received during the workshops have helped to shape the investment initiatives presented in this draft investment plan. Comments on this draft Investment Plan will be accepted at the September 27, 2012 workshop and in writing until October 1, 2012.

The Energy Commission plans to consider adopting a revised draft investment plan at the October business meeting. The schedule calls for submitting a proposed investment plan to the CPUC on November 1, 2012. Consistent with the CPUC's Phase 2 Decision, the CPUC will consider the Energy Commission's Plan, along with the Investment Plans of the three IOUs. The Phase 2 Decision schedule calls for CPUC approval of the Investment Plan in May 2013. Staff plans to hold scoping workshops for the second triennial Investment Plan in early 2014, covering the 2015-2017 funding cycle.

The four administrators, including the Energy Commission and the three utilities, will file annual reports to the CPUC, starting in February 2013 and through February 2020, for review and oversight by the CPUC.

In addition, the Energy Commission is considering the formation of advisory groups to inform Plan implementation, to avoid duplication of effort, and to facilitate sharing of research results.

Appendix

[To be added (will include sample solicitations, including selection criteria; example of a research roadmap; and a summary of stakeholder comments and staff responses]